DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

Electro-Voice Site
Operable Unit 2 - Off-Property Groundwater
Buchanan, Michigan

Statement of Basis and Purpose

This decision document presents U.S. EPA's selected remedial action for the Electro-Voice site in Buchanan, Michigan. U.S. EPA developed this remedial action in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, 42 U.S.C. §§ 9601-9675. This selected action is consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. Part 300, to the extent practicable. This decision is based on the administrative record file for this site.

The State of Michigan has indicated that it is considering concurring with U.S. EPA's selected remedy. If the State does concur, the State's letter of concurrence will be attached to this record of decision (ROD).

Assessment of the Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Description of the Selected Remedy

This ROD is for Operable Unit 2 - Off-Property Groundwater, and is the final ROD for this site. The ROD for Operable Unit 1 addressed the sources of the off-property groundwater contamination. These source areas included soil contamination and the more highly contaminated on-property groundwater. These areas were remediated through treatment and engineering controls constructed from 1993 to 1997.

This ROD addresses the remaining, off-property groundwater contamination and uses natural processes, monitoring, institutional controls and contingency actions to eliminate or reduce the risks posed by the off-property groundwater.

The major components of the selected remedy include:

- Natural attenuation to restore the off-property groundwater to maximum contaminant levels (MCLs) and Michigan Act 451 Part 201 generic residential drinking water criteria for trichloroethene (TCE) and vinyl chloride. The primary attenuation processes affecting the off-property groundwater at Electro-Voice are stream capture and dilution, with some biodegradation. The estimated cleanup time frame is approximately 53 to 66 years.

- Institutional controls to limit groundwater use until the aquifer is restored to cleanup levels. The City of Buchanan currently has a local ordinance (Chapter 38, Article IV, Sections 38-90 to 38-93) that prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated. The city has also drafted a new ordinance intended to be consistent with the requirements for institutional controls in Michigan Act 451, Natural Resources and Environmental Protection Act Part 201. The city is in the process of implementing the new ordinance and revising the boundaries of the restricted area to incorporate additional data Electro-Voice collected during a 1998 off-property groundwater investigation. During the remedial action for Operable Unit 1, Electro-Voice also obtained deed restrictions prohibiting the installation of drinking water wells for about half of the properties within the area of groundwater contamination.

  All Buchanan residents except one residence located one mile northwest of the site are connected to the municipal water supply. The city wells are located about three-fourths of a mile west of Electro-Voice and are either upgradient or side gradient of the off-property groundwater contamination. The city wells are not in danger of becoming contaminated by the off-property groundwater contamination. There are private wells northwest of Buchanan and east of Buchanan that are outside Buchanan city limits. The private well one mile northwest of Electro-Voice and the private wells northwest of Buchanan are about three-fourths of a mile side-gradient to the off-property groundwater contamination. The private wells east of Buchanan are about one-third to one-half of a mile side-gradient to the off-property groundwater contamination. None of the private wells are likely to be impacted by off-property groundwater contaminants.

- Monitoring to track the progress of natural attenuation over time and to ensure that the remedy remains protective of human health and the environment until the cleanup levels are attained. The monitoring will also ensure that the level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D does not pose any unacceptable health risks, and that the levels of chromium, copper and zinc detected above background levels and Michigan Act 451 Part 31 generic groundwater surface water interface (GSI) criteria or calculated final chronic GSI values in near-property groundwater will not affect McCoy Creek as the contaminated groundwater discharges into the creek. Changes in land and groundwater use and changes in groundwater conditions that could affect the performance or the protectiveness of the remedy will also be identified.

- Contingency actions that will be implemented if monitoring identifies the need for modifications or changes in the remedy. Possible contingency actions include confirmation sampling; collecting groundwater samples more frequently; collecting surface water and/or sediment samples from McCoy Creek; installing new monitoring wells; pursuing additional deed restrictions; notifying the City of Buchanan that the city should update the restricted area in the local ordinance; evaluating whether McCoy Creek or any drinking water supplies are threatened and whether additional response actions, such as the construction of a groundwater containment system or a treatment system is necessary; and implementing additional response actions, such as a groundwater containment system or a treatment system as necessary to protect human health and the environment and return the off-property groundwater to a drinking water supply within a time frame that is reasonable based on the conditions at this site. This time frame is approximately 53 to 66 years.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. The selected remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable.

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. This ROD addresses off-property groundwater. No source materials constituting principal threats will be addressed within the scope of this action. U.S. EPA selected remedies satisfying the statutory preference for treatment in the June 23, 1992 ROD for Operable Unit 1 for drywell area soils and the more highly contaminated on-property groundwater.

Because this remedy will result in hazardous substances remaining in the off-property groundwater above levels that allow for unlimited use and unrestricted exposure, U.S. EPA will conduct a review within five years after the initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

U.S. EPA has determined that its future response at this site does not require physical construction. Therefore, the site now qualifies for inclusion on the Construction Completion List.

9/21/99
Date

Wm. E. Muno
William E. Muno
Superfund Division Director

ROD Data Certification Checklist

The Decision Summary section of this Record of Decision includes the following information. Additional information can be found in the administrative record file for this site.

- Chemicals of concern (COCs) and their respective concentrations.
- Cleanup levels established for COCs and the basis for the levels.
- Current and future land and groundwater use assumptions.
- Land and groundwater use that will be available at the site as a result of the selected remedy.
- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- Decisive factors that led to selecting the remedy (i.e., describes how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria).

The risks at the Electro-Voice site were quantitatively evaluated by Electro-Voice in the 1991 Risk Assessment (e.g., excess lifetime cancer risk and hazard index calculated), and qualitatively evaluated by U.S. EPA in an updated, streamlined risk evaluation. In the streamlined risk evaluation, U.S. EPA evaluated the risks associated with the off-property groundwater under current conditions. U.S. EPA did this by evaluating the risks for relevant exposure pathways by comparing the current COCs in the off-property groundwater at current concentrations to the following applicable criteria:

- Background levels (for metals)
- Federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act
- Michigan Act 451 Part 201 generic residential drinking water criteria
- Michigan Act 451 Part 201 generic residential groundwater volatilization to indoor air inhalation criteria
- Michigan Act 451 Part 31 groundwater surface water interface (GSI) criteria for the protection of McCoy Creek biota (final chronic values)
- Michigan Act 451 Part 31 GSI criteria for human non-drink values for surface water

U.S. EPA calculated final chronic values for chemicals that are pH dependent by assuming a hardness of 100 mg/L $CaCO_3$ in McCoy Creek.

9/21/99
Date

W. E. Muno
William E. Muno
Superfund Division Director

U.S. EPA Superfund
Record of Decision

Electro-Voice Site
Operable Unit 2 - Off-Property Groundwater Contamination

Buchanan, Michigan
September, 1999

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SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

1. SITE NAME, LOCATION AND DESCRIPTION

Electro-Voice (now called EV International) manufactures sound equipment and is located at 600 Cecil Street in Buchanan, Michigan (Figure 1). Buchanan is in Berrien County in the southwest corner of Michigan. The CERCLIS identification number for the site is MID005068143.

Activities at Electro-Voice include die casting, machining, assembly, painting, electroplating and administration. Research and development activities were moved to another location in 1988. The plant includes a building, two parking lots and an open field. The property is surrounded by a residential area, a few commercial properties and an elementary school. Groundwater contamination extends from Electro-Voice about one-half mile north of the site to about 500 feet beyond McCoy Creek.

All Buchanan residents except one residence located one mile northwest of the site are connected to the municipal water supply. The city wells are about three-fourths of a mile west of Electro-Voice and are either upgradient or side gradient of the off-property groundwater contamination. These wells are not in danger of becoming contaminated by the off-property groundwater contamination. There are private wells northwest of Buchanan and east of Buchanan that are outside Buchanan city limits. The private well one mile northwest of Electro-Voice and the private wells northwest of Buchanan are about three-fourths of a mile side-gradient to the off-property groundwater contamination. The private wells east of Buchanan are about one-third to one-half of a mile side-gradient to the off-property groundwater contamination. None of the private wells are likely to be impacted by off-property groundwater contaminants.

Activities at the site are being conducted by Mark IV Industries, the potentially responsible party (PRP) for the site, under the oversight of U.S. EPA and the Michigan Department of Environmental Quality (MDEQ).

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Former Operations and Disposal Areas

The contamination at the site resulted from Electro-Voice's discharge of electroplating wastes into two clay-lined lagoons from 1952 to 1962, and from the disposal of paint wastes and solvents into a drywell from 1964 to 1973 (Figure 2). The waste disposal activities contaminated the groundwater with volatile organic compounds (VOCs). The groundwater contamination extends about one-half mile north of Electro-Voice beyond McCoy Creek to about the intersection of Third Street and Red Bud Trail, about 500 feet north of McCoy Creek. In 1980 Electro-Voice excavated the contents of one of the lagoons and filled both lagoons with fill material. However, the soil beneath and around the excavated lagoon and in the unexcavated lagoon remained contaminated.

Previous Studies and Cleanup Plans

In 1987 Electro-Voice entered into an administrative order by consent with U.S. EPA to conduct a remedial investigation and feasibility study (RI/FS). Electro-Voice completed the RI in 1990. However, in 1991, Electro-Voice failed to revise its draft FS report consistent with the requirements of the National Contingency Plan (NCP). U.S. EPA completed the FS in 1991 and issued its proposed cleanup plan for the site in September 1991. U.S. EPA's proposed cleanup plan was to construct a hazardous waste landfill cap over the lagoon area, install a soil vapor extraction system to cleanup the contaminated soil in the drywell area, and install a groundwater pump-and-treat system to clean up the entire area of groundwater contamination.

During the public comment period, U.S. EPA received a substantial number of comments urging U.S. EPA to clean up the more contaminated on-property groundwater, and to monitor off-property groundwater instead of actively remediating the off-property groundwater. Based on these comments, U.S. EPA divided the site work into two operable units (OUs). The OU1 ROD addressed the lagoons, the drywell area soils and on-property groundwater. The OU1 ROD also included five years of off-property groundwater monitoring. This additional data would be used by U.S. EPA to evaluate the effects of the on-site cleanup actions on off-property groundwater before selecting a final remedy for the off-property groundwater.

U.S. EPA issued the OU1 ROD in 1992. In 1993, 1995 and 1996 U.S. EPA updated the OU1 ROD in explanations of significant differences (ESDs). The ESDs revised the list of cleanup standards for drywell area soils and on-property groundwater; selected a new cleanup technology called a subsurface volatilization and ventilation system (SVVS) for drywell area soils and on-property groundwater instead of soil vapor extraction and groundwater pump-and-treat; and revised the cleanup standards to incorporate changes in Michigan Act 451 Part 201.

Lagoon and Drywell Area Cleanup

In 1993 Electro-Voice (now succeeded by Mark IV Industries) entered into a consent decree with U.S. EPA to conduct the remedial design and remedial action (RD/RA) for OU1. Electro-Voice completed the lagoon cleanup in 1997. The lagoon cleanup involved constructing a hazardous waste landfill cap over the lagoon area to contain soil contaminants, reduce contaminant migration to the water table, and prevent people from coming into contact with the contaminated materials in the lagoons. The cap consists of three feet of clay covered by a two foot layer of sand and four inches of topsoil.

The contaminated soils in the drywell area and on-property groundwater are being cleaned up by the SVVS. A vendor for the SVVS technology installed this system in the drywell area in 1993 as part of U.S. EPA's Superfund Innovative Technology Evaluation Program. The

SVVS uses a combination of air injection, soil vapor extraction and in-situ biodegradation technologies. U.S. EPA selected the SVVS technology for drywell area soils and on-property groundwater in the 1995 ESD. The SVVS will operate until soil and groundwater contaminants are reduced to cleanup levels. Contaminant concentrations in the on-property groundwater have been below cleanup levels since 1996. U.S. EPA is currently evaluating the results of soil sampling in the drywell area to determine if the soil cleanup is complete and if the SVVS can be shut down.

The drywell area and the capped lagoons are located in the open field west of the manufacturing building. The field is surrounded by a fence with locked gates to prevent unauthorized access. Electro-Voice and Mark IV Industries have conducted groundwater monitoring for VOCs in off-property groundwater since 1993.

3. COMMUNITY PARTICIPATION

U.S. EPA maintains an administrative record file and an information repository for site documents at the Buchanan Public Library. U.S. EPA also maintains an administrative record file for the site at the U.S. EPA Region 5 Superfund Division Records Center. These repositories contain all major site documents including the 1990 RI and Risk Assessment, the 1991 FS, the 1992 ROD for OU1 and the 1993, 1995 and 1996 ESDs. In July 1999 U.S. EPA added the June 1999 Technical Memorandum for the Evaluation of Off-Property Groundwater and U.S. EPA's proposed cleanup plan for the off-property groundwater to the repositories.

U.S. EPA announced its proposed cleanup plan for the off-property groundwater in advertisements published in the Niles Star on June 25, 1999 and in the Berrien County Record on June 30, 1999. The advertisements included information about U.S. EPA's proposed plan, the other alternatives that U.S. EPA considered, the upcoming public meeting and the public comment period. On July 3, 1999, U.S. EPA mailed several hundred copies of the proposed plan to local residents and other interested parties. U.S. EPA accepted public comments on its proposed plan from July 9 to August 8 1999. U.S. EPA did not receive any requests to extend the public comment period.

On July 14, 1999, U.S. EPA held a public meeting in Buchanan. At the meeting, U.S. EPA presented its proposed plan for the off-property groundwater to the community and answered questions about the site and the other cleanup alternatives that U.S. EPA considered. U.S. EPA also used this meeting to solicit a wider cross-section of community input on the current and potential future uses of groundwater in the area. The meeting was attended by approximately 12 people, including three Buchanan city commissioners, staff from the state representative's office, two newspaper reporters, a local television news reporter, two residents, an Electro-Voice employee and two of Mark IV's engineering consultants. A summary of the comments that U.S. EPA received during the public comment period and U.S.

EPA's responses to these comments is in the responsiveness summary, which is part of this ROD and is in Appendix A.

4. SCOPE AND ROLE OF OPERABLE UNIT

Based on the comments U.S. EPA received during the 1991 public comment period, U.S. EPA divided the site work into two operable units (OUs):

Operable Unit 1: Contaminated soils in the drywell area, lagoons and on-property groundwater

Operable Unit 2: Off-property groundwater contamination

U.S. EPA selected a remedy for OU1 in a ROD signed on June 23, 1992. The OU1 ROD was updated in ESDs issued in 1993, 1995 and 1996. The contaminated soils in the drywell area, the lagoons and the on-property groundwater were addressed through remedial actions conducted from 1993 to 1997.

This ROD is for OU2 and addresses the off-property groundwater. The off-property groundwater is contaminated by trichloroethene (TCE) and vinyl chloride. The ingestion of off-property groundwater poses a potential future risk to human health. This is because the concentrations of TCE and vinyl chloride exceed the federal maximum contaminant levels (MCLs) for drinking water, as specified in the Safe Drinking Water Act, 42 U.S.C. §§ 300f-300j-11, and the Michigan Act 451 Part 201 Generic Residential Drinking Water Criteria for these chemicals. The concentrations of TCE and vinyl chloride also exceed the cleanup levels established for these chemicals in on-property groundwater in the OU1 ROD and 1996 ESD. The remedy selected in this ROD for OU2 will be U.S. EPA's final response action for the Electro-Voice site.

5. CURRENT SITE CONDITIONS

Site Investigations

Electro-Voice conducted a RI at the site from 1987 to 1990. The RI included a series of field investigations to collect information to characterize the nature and extent of the contamination at the site and evaluate the associated risks. The RI included:

- Site mapping
- Subsurface soil sampling in the south lagoon, north lagoon, fuel tank area and drywell area
- Soil sampling at background locations
- Installing groundwater monitoring wells at and downgradient of the site to characterize the nature and extent of the groundwater contamination
- Collecting background groundwater samples

- Porosity and hydraulic conductivity testing
- Lysimer installation, purging, sampling and analysis
- Groundwater flow mapping
- Residential well survey
- McCoy Creek flow measurements
- Surface soil sampling in the lagoon area (conducted by U.S. EPA)
- Surface water sampling for VOCs in McCoy Creek (conducted by U.S. EPA)

During the RI Electro-Voice also reviewed background reports and other published documents to collect information about surface features, meteorology, geology, hydrogeology, hydrology, land and groundwater use and demography.

Starting in 1993, Electro-Voice also collected groundwater samples from off-property groundwater monitoring wells on a regular basis. The sampling was conducted to evaluate the effects of the on-site cleanup actions on off-property groundwater, and to determine whether there were any changes in groundwater quality and characteristics over time. Electro-Voice sampled twenty wells for VOCs on a quarterly basis and nine wells for VOCs annually. Also, in 1998, Electro-Voice conducted an additional investigation to evaluate the off-property groundwater. The purpose of the 1998 investigation was to:

- Assess whether off-property groundwater was impacted by site-related metals or SVOCs;
- Confirm that the vertical and horizontal extent of the VOC contamination was defined;
- Evaluate groundwater flow direction under high and low flow conditions;
- Evaluate the potential for impacts to McCoy Creek from groundwater venting;
- Assess the need for additional surface water and sediment sampling; and
- Provide data necessary to calibrate a fate and transport model (if required).

The additional off-property groundwater investigation included:

- Replacing, repairing and installing new staff gauges along McCoy Creek;
- Installing six new groundwater monitoring wells and two temporary wells;
- Slug tests on monitoring wells located north of McCoy Creek;
- Sampling of all new and existing monitoring wells for VOCs and metals, and sampling all new wells and selected existing wells for semivolatile organic compounds; and
- Measuring static water levels in all monitoring wells and at staff gauges.

The results of the quarterly and annual groundwater monitoring and the additional off-property groundwater investigation are presented in the June 1999 Technical Memorandum for the Evaluation of Off-Property Groundwater.

Current Conditions

Electro-Voice occupies 11 acres and consists of a building and two parking lots. The drywell area is currently undergoing remediation and is located immediately west of the building. The capped lagoons are also west of the building. The drywell area and the capped lagoons are both located in a fenced, vacant field.

McCoy Creek is located about one-half mile north of the site. The creek has an average depth of 2 feet and an average width of 12 feet. Stream gauging conducted during October 1989 measured a flow rate of 12 to 14 ft/second. McCoy Creek flows about three-fourths of a mile north-northeast of downtown Buchanan and empties into the St. Joseph River. The St. Joseph River flows northwest and empties into Lake Michigan at St. Joseph.

Electro-Voice's sampling shoes that the off-property groundwater is contaminated with TCE and its breakdown product cis-1,2-dichloroethene (cis-1,2-DCE). Another breakdown product, vinyl chloride, is found in one monitoring well (MW-30) located north of McCoy Creek (Table 1). From 1993 to 1998, Electro-Voice also intermittently detected vinyl chloride at low concentrations of 0.1 to 0.5 ppb in MW-14 and MW-28. TCE, cis-1,2-DCE and vinyl chloride are toxic chemicals and have the potential to cause cancer and other health effects. The 1998 metals sampling also indicates that chromium, copper and zinc are present above background levels in the area of groundwater contamination near the site (MW-14, MW-16, MW-17 and MW-18) and may be from Electro-Voice. Farther from the site, in the area of groundwater contamination near McCoy Creek, the concentrations of these metals are below background.

The other metals that Electro-Voice detected in the groundwater above background concentrations occur outside or at the edge of the off-property groundwater contamination. There is no discernable pattern in the distribution or the concentrations of these metals that indicates that these metals are from the site (Figure 3). The highest concentrations of metals were detected in groundwater monitoring well MW-35. This well is located in an industrial area north of McCoy Creek and is outside the area of the Electro-Voice groundwater contamination. A detailed analysis of the metals results is in Attachment 1. The chemicals of concern (COCs) in the off-property groundwater and their concentrations are shown in Table 2.

The off-property groundwater contamination extends one-half mile north of Electro-Voice beyond McCoy Creek to about the intersection of Third Street and Red Bud Trail, about 500 feet north of McCoy Creek. At its widest point the groundwater contamination is about 1,125 feet wide. The groundwater flows toward McCoy Creek in an unconfined sand and gravel aquifer underlain by a clay-rich till unit. In some places the clay-rich till is absent and the sand and gravel unit is directly over bedrock. The bedrock is Antrim shale, which is composed of shale and/or limestone. The Antrim formation is very dense and relatively impermeable, and is not considered to be a source of groundwater. Driller's logs of the region indicate that a lower confined aquifer also exists in localized areas. In the areas where both aquifers exist, they are separated by a clay-rich confining layer. The lower confined aquifer was not encountered in any of the soil borings drilled during the RI, the 1994 lower aquifer investigation or the 1998 off-property groundwater investigation.

Near McCoy Creek, about 20 percent of the groundwater flows into the creek along about a 650 foot zone of the creek between staff gauge MC-5 and monitoring well MW-28. The remaining 80 percent of the groundwater continues north and flows under the creek. North of McCoy Creek the groundwater flow turns slightly east and nearly all of the contaminated groundwater ultimately discharges back into McCoy Creek near staff gauge MC-7 by Third Street.

The depth to the water table ranges from about 50 feet below ground surface (ft-bgs) in the drywell area to about 25 to 30 ft-bgs in the lagoon area. Near McCoy Creek the depth to the water table decreases to about 10 ft-bgs. The thickness of the aquifer also varies from about 35 to 55 feet in most of the area between Electro-Voice and McCoy Creek, to about 10 to 15 feet near the creek. The average groundwater velocity between the Electro-Voice property and McCoy Creek is approximately 900 ft/year. Static groundwater elevation data collected from pairs of nested wells indicate that the majority of the groundwater flow is horizontal with minimal downward vertical gradients in some areas (zero to 0.0097 ft/ft). The groundwater quality data indicates that the groundwater contaminants remain primarily within the upper zone of the aquifer and that the observed downward vertical gradients do not significantly contribute to the migration of contaminants to the lower portions of the aquifer.

Electro-Voice's 1998 off-property groundwater investigation and the off-property groundwater monitoring conducted since 1993 indicate that McCoy Creek is capturing the contaminants in the off-property groundwater, and that chemical concentrations in the groundwater are decreasing (compare Figures 4 through 10). These figures show contaminant concentrations of TCE for each year's annual sampling event in December. The concentration data were contoured using the Department of Defense Groundwater Modeling System two-dimensional geostatistical software module. For each map, the scatter-point data sets were interpolated using the natural neighbor method with a gradient nodal function. In Figure 10 (1998 data), the contours of the data were manually adjusted in the area near McCoy Creek to correspond to the conceptual model of groundwater flow at the site.

In 1993, the concentration of TCE in the most contaminated off-property monitoring wells ranged from 39 to 56 ppb in MW-23 and 39 to 60 ppb in MW-26. The state and federal drinking water standard for TCE is 5 ppb. By 1998 the maximum concentration of TCE detected in off-property groundwater was 26 ppb. Similar reductions were seen for cis-1,2-DCE. The concentration of vinyl chloride in monitoring well MW-30 fluctuated between 1 and 9 ppb from 1993 to 1998. The state and federal drinking water standard for vinyl chloride is 2 ppb. From 1993 to 1998 vinyl chloride was also detected intermittently at low concentrations ranging from 0.1 to 0.5 ppb in monitoring well MW-14 and at 0.2 ppb in MW-28.

Because nearly all of the contaminated groundwater ultimately discharges to McCoy Creek from the north/west side of the creek near Third Street, the groundwater contamination is not spreading beyond the area near the intersection of Third Street and Red Bud Trail. The ultimate venting of impacted groundwater to McCoy Creek near Third Street is based on groundwater flow direction, vertical hydraulic gradients, and the analytical data for MW-33, MW-34, MW-35 and MW-36. However, groundwater monitoring data is not currently available south/east of McCoy Creek to verify that the groundwater contaminants are fully venting into McCoy Creek in this area. A monitoring well on the south/east side of McCoy Creek between staff gauges MC-7 and MC-8 is required to verify the northeast extent of the groundwater contamination and to confirm the full venting of groundwater contaminants in this area.

Conceptual Site Model

Electro-Voice's discharge of electroplating wastes into the lagoons and the disposal of paint wastes and solvents into the drywell contaminated the soil. As rainwater infiltrated through the soil, several of the contaminants were washed into the groundwater. The contaminants are slowly moving with the groundwater over time and are discharging to McCoy Creek. Along the way, some of the groundwater contaminants are breaking down into other chemicals. In McCoy Creek, contaminants may attach to sediments in the creek, flow along with the creek water, or volatilize into the air and become dispersed.

Potential receptors of the off-property groundwater contamination include residents who may use the off-property groundwater as a water supply. These people would be exposed to groundwater contaminants through ingestion or via inhalation and dermal contact while showering. Occupants of buildings with basements near the water table (e.g., businesses located along Front Street) may also be exposed to VOCs via inhalation if groundwater contaminants volatilize into basements. Other potential receptors include people who may wade or fish in McCoy Creek and terrestrial and aquatic biota that may be exposed to the groundwater contaminants venting to McCoy Creek. Potential exposure routes under this scenario include ingestion and dermal contact with the surface water and sediments in McCoy Creek and the ingestion of fish from McCoy Creek.

6. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

The Electro-Voice site is currently zoned for and occupied by industrial use. The original building was constructed at the site in 1902 and industrial activities have been documented at the site since the late 1920s and early 1930s. The adjacent land use is primarily residential with some commercial properties. Stark Elementary School is just east of Electro-Voice east of Liberty Street.

Near McCoy Creek the land use becomes commercial. Buchanan's downtown area is located near the intersection of Front Street and Red Bud Trail. Industrial areas are located on both sides of McCoy Creek east of Red Bud Trail. Based on existing land use and zoning maps

U.S. EPA reasonably anticipates that future land use in the area of the off-property groundwater contamination will remain primarily residential, with commercial and industrial land uses near McCoy Creek.

Groundwater Uses

The Buchanan City Clerk's Office informed U.S. EPA that all residents of the City of Buchanan, except for one residence located one mile northwest of the Electro-Voice site, are connected to the municipal water supply.[1] The city wells are located about three-fourths of a mile west of Electro-Voice and are either upgradient or side gradient of the off-property groundwater contamination. These wells are not in danger of becoming contaminated by the off-property groundwater contamination.

Well logs obtained from the MDEQ indicate that there are private wells northwest of Buchanan and east of Buchanan that are outside Buchanan city limits. The private well one mile northwest of Electro-Voice and the private wells northwest of Buchanan are about three-fourths of a mile side-gradient to the off-property groundwater contamination. The private wells east of Buchanan are about one-third to one-half of a mile side-gradient to the off-property groundwater contamination. None of the private wells are likely to be impacted by off-property groundwater contaminants.

In spring 1999 a resident drilled a well near the intersection of Cecil Street and Rynearson Road which is on the edge of the TCE plume. The resident is connected to the city water supply and has informed the Berrien County Health Department that this well is only being used for irrigation purposes. The well is not connected to an occupied structure.

U.S. EPA groundwater classification guidelines indicate that the groundwater in the area of the off-property groundwater contamination is a potential supply of drinking water. Buchanan obtains its water supply from groundwater and areas just outside of Buchanan city limits are supplied by private wells. However, U.S. EPA does not anticipate that anyone will use the off-property groundwater as a source of drinking water in the foreseeable future. This is because the city's wells are located outside of the off-property groundwater contamination and there is an adequate groundwater supply available.

Also, in 1996 the City of Buchanan adopted a local ordinance (Chapter 38, Article IV, Sections 38-90 to 38-93) that prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated. The city has also drafted a new ordinance intended to be consistent with the requirements for institutional controls in Michigan Act 451, Natural Resources and Environmental Protection Act Part 201. The city is in the process of implementing the new ordinance and revising the boundaries of the restricted area to incorporate the additional data collected during Electro-Voice's 1998 off-property groundwater

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[1] *The address of this private well is 307 Miller Street.*

investigation. A copy of Buchanan ordinance Chapter 38, Article IV, Sections 38-90 to 38-93 and a copy of the draft revised ordinance are provided in Attachment 2.

About one-half of the properties within the area of groundwater contamination also have deed restrictions which prohibit the installation of drinking water wells on the property. The deed restrictions were obtained by Electro-Voice as part of the RA for OU1. A copy of one of the deed restrictions is provided in Attachment 2 as an example.

7. RISK SUMMARY

The baseline risk assessment estimates the risks the site poses if no action were taken. It provides the basis for taking an action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The risks at the Electro-Voice site were evaluated by Electro-Voice in the 1991 Risk Assessment, and by U.S. EPA in an updated, streamlined risk evaluation. U.S. EPA performed the updated, streamlined risk evaluation to evaluate the risks associated with the off-property groundwater under current conditions.

1991 Risk Assessment

The 1991 Risk Assessment calculated excess lifetime cancer risks and hazard indices for potential future exposure to groundwater, recreational use of McCoy Creek and exposure to groundwater vapors in Front Street basements. The risks for the potential future residential use of groundwater were calculated based on the chemicals and contaminant concentrations detected in on- and off-property groundwater combined at the time of the RI. The risks associated with recreational use of McCoy Creek and exposure to groundwater vapors in Front Street basements were also calculated based on much higher concentrations than are currently detected in the groundwater. The results of the 1991 Risk Assessment are summarized in Table 3.

<u>Human Health</u>

The results of the 1991 Risk Assessment indicate that there would be unacceptable cancer and non-cancer risks from the residential use of groundwater. These risks would be posed through ingestion of groundwater and dermal contact with the groundwater while showering. The 1991 Risk Assessment did not identify any unacceptable risks for recreational fisherman using McCoy Creek or for workers at Front Street businesses who might be exposed to vapors seeping into basements from the off-property groundwater. However, if vinyl chloride (a degradation product of TCE and cis-1,2-DCE) was present in the groundwater near Front Street businesses at a concentration of 5 ppb, the risk assessment calculated an unacceptable cancer risk of $5x10^{-4}$ for the inhalation of vinyl chloride vapors. However, a concentration of 5 ppb for vinyl chloride is well below the Michigan generic groundwater volatilization to indoor air criteria for vinyl chloride of 110 ppb.[2]

During the past six years of quarterly and annual groundwater monitoring, vinyl chloride was only detected consistently in one well (MW-30) at concentrations ranging from 1 to 9 ppb. This well is located near the corner of Red Bud Trail and Dewey Street and is in a small park. From 1993 to 1998 vinyl chloride was also detected intermittently at low concentrations of 0.1 to 0.5 ppb in monitoring wells MW-14 and MW-28. No vinyl chloride has been detected in monitoring wells that are closer to Front Street (e.g., MW-26S and MW-26D).

Ecological Risks/McCoy Creek

McCoy Creek is a designated protected trout stream by the Michigan Department of Natural Resources (MDNR) and is stocked with brown trout at locations upstream from Buchanan. The 1991 Risk Assessment and additional surface water data U.S. EPA collected in 1991 did not identify any unacceptable ecological impacts to McCoy Creek from the off-property groundwater. Three out of five surface water samples collected by U.S. EPA in 1991 contained TCE at a concentration of 0.6 ppb, which is well below the Michigan human non-drink value for surface water of 44 ppb and final chronic ambient water quality of 200 ppb.[3]

Streamlined Risk Evaluation of Current Conditions

U.S. EPA's streamlined risk evaluation evaluated current and potential future exposure to the COCs in the off-property groundwater at current concentrations under exposure pathways similar to those in the 1991 Risk Assessment. The streamlined risk evaluation involved comparing current chemical concentrations in the off-property groundwater to relevant federal and state criteria for each scenario. The data used by U.S. EPA in the streamlined risk evaluation was generated by Electro-Voice. U.S. EPA did not rely on any data generated by U.S. EPA in its risk evaluation.

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[2]*The apparent discrepancy between the inhalation risk for vinyl chloride in the 1991 Risk Assessment and the Michigan generic groundwater volatilization to indoor air criterion for vinyl chloride is due to Michigan's use of a less conservative inhalation slope factor and a different predictive model. The inhalation slope factor used by Michigan is less conservative than the slope factor used in the 1991 Risk Assessment, however, the model used by Michigan is more widely used than the model used in the 1991 Risk Assessment and represents the standard practice for quantitatively evaluating the groundwater volatilization to indoor air pathway. This model also considers dispersion, air exchange and the effectiveness of subsurface barriers (e.g., foundations) in a more detailed and quantitative manner, which also likely yields more representative estimates of indoor air concentrations.*

[3]*The data collected by U.S. EPA in 1991 is being provided for background information purposes only and was not used by U.S. EPA in selecting this final remedy for off-property groundwater. All data used to support this remedy for off-property groundwater was generated by the PRP and validated (30% data validation) by U.S. EPA's oversight contractor CH2M Hill.*

The COCs were identified in Table 2. All chemical concentrations were compared to the relevant criteria. The exposure scenarios that U.S. EPA evaluated in the streamlined risk evaluation and the federal and state criteria U.S. EPA used to evaluate each scenario are listed in Table 4.

Since U.S. EPA compared the COCs in the off-property groundwater to federal and state criteria, U.S. EPA did not conduct a toxicity assessment for each chemical. However, TCE is classified as a probable human carcinogen (Group B2) and vinyl chloride is classified as a known human carcinogen (Group A). Chromium, copper and zinc also have the potential to cause non-carcinogenic health effects. The streamlined risk evaluation is shown in detail in Table 5 and is summarized in Table 6.

Risk Characterization

Current Risks

Human Health: There are no current risks to human health from the off-property groundwater contamination. All Buchanan residents except one residence located one mile northwest of the site are connected to the municipal water supply. The city wells are about three-fourths of a mile west of Electro-Voice and are either upgradient or side gradient of the off-property groundwater contamination. The city wells are not in danger of becoming contaminated by the off-property groundwater contamination. The private well one mile northwest of Electro-Voice and the private wells northwest of Buchanan are about three-fourths of a mile side-gradient to the off-property groundwater contamination. The private wells east of Buchanan are about one-third to one-half of a mile side-gradient to the off-property groundwater contamination. None of the private wells are likely to be impacted by off-property groundwater contaminants.

None of the concentrations of the COCs exceed Michigan groundwater volatilization to indoor air criteria or Michigan human non-drink GSI values for surface water. The groundwater volatilization to indoor air criteria protect people from being exposed to groundwater contaminants that could seep into basements and contaminate indoor air at levels that are harmful to people. The human non-drink GSI values protect people who swim or wade in creeks, rivers and lakes from being exposed to groundwater contaminants that could discharge into surface water at harmful levels.

Ecological Risks/McCoy Creek: There are no current risks to McCoy Creek from the off-property groundwater contamination. Electro-Voice did not detect TCE, vinyl chloride or cis-1,2-DCE in any monitoring wells in the area of groundwater contamination near the creek (MW-24, MW-26S, MW-26D, MW-27S, MW-27D, MW-28, MW-30 and MW-37) above Michigan generic GSI values. These generic GSI values protect people, plants and animals from being exposed to groundwater contaminants that might discharge into creeks, rivers and lakes at levels that would be harmful to human health or the environment.

Electro-Voice also did not detect chromium, copper or zinc above background levels in any wells in the area of groundwater contamination near the creek. Chromium was detected above background levels in MW-35 and copper and zinc were detected above background levels and U.S. EPA's calculated Michigan final chronic GSI values in MW-35. However, MW-35 is located in an industrial area north of McCoy Creek and is not within the area of off-property groundwater contamination.

Potential Future Risks

Human Health: The off-property groundwater contamination poses a potential future risk to residents under a future drinking water scenario. TCE is above MCLs and Michigan generic residential drinking water criteria in 8 out of 36 monitoring wells. Figure 3 shows the current extent of the TCE contamination. Vinyl chloride is above MCLs and Michigan generic residential drinking water criteria in 1 monitoring well (MW-30). The concentrations of TCE and vinyl chloride detected in the off-property groundwater also exceed the cleanup standards established for these chemicals in on-property groundwater in the 1992 ROD and 1996 ESD.

The concentration of zinc detected above background levels in MW-18D exceeds the Michigan generic residential drinking water criteria for zinc. However, there is no MCL for zinc, and the only other well in which zinc was detected above background levels and the Michigan generic residential criteria is MW-35. This well is located in an industrial area north of McCoy Creek and is not within the area of off-property groundwater contamination. Cis-1,2-DCB, chromium and copper were not detected above any drinking water standards.

Ecological Risks/McCoy Creek: Chromium, copper and zinc were detected in the area of off-property groundwater contamination above background levels in three wells near Electro-Voice. Chromium was detected above background levels in MW-16 and MW-17; copper in MW-17 and MW-18; and zinc in MW-18. Chromium, copper and zinc were also detected above background levels in MW-35. However, MW-35 is located in an industrial area north of McCoy Creek and is not within the area of off-property groundwater contamination. Copper was also detected above background levels in TW-19I and MW-38S. However, TW-19I and MW-38S are also outside of the area of off-property groundwater contamination.

The concentration of chromium in MW-16 (sample analyzed for total chromium) is just above the Michigan generic GSI for hexavalent chromium, but is below the Michigan final chronic GSI value U.S. EPA calculated for trivalent chromium. The concentrations of copper and zinc in MW-18D also exceed the Michigan final chronic GSI values U.S. EPA calculated for these chemicals.

MW-16, MW-17 and MW-18 are located near Electro-Voice and are 1,375 to 2,250 feet from McCoy Creek. Near McCoy Creek, the concentrations of these chemicals are below background. However, these chemicals could pose a risk to McCoy Creek if they moved with the groundwater and emptied into McCoy Creek at levels that would threaten the creek.

Uncertainty
The main uncertainty associated with the updated risk evaluation is that U.S. EPA compared chemical concentrations to relevant federal and state standards instead of re-calculating excess lifetime cancer risks and hazard indices. This may result in either an under- or overestimation of risk. Federal and state standards for a scenario may only be based on one exposure pathway. For example, MCLs and Michigan drinking water criteria are only based on the ingestion of groundwater and do not consider dermal contact with groundwater or the inhalation of vapors while showering. As a result, U.S. EPA's analysis may underestimate the risks from the residential use of groundwater. U.S. EPA's streamlined risk evaluation also did not consider the cumulative effects of exposure to multiple chemicals. This may also underestimate the risks.

On the other hand, most federal and state standards are set at the more protective end of the risk range. This may result in an overestimation of risk. For example, MCLs are usually set at 10^{-6} and Michigan drinking water criteria are either set at MCLs or a risk of 10^{5}. Also, U.S. EPA's comparison of each COC concentration to federal and state standards instead of calculating the 95 percent upper confidence interval on the arithmetic mean may also overestimate the actual risk. One example of this is zinc, which was only detected above the Michigan generic residential drinking water criteria at one location. Finally, U.S. EPA also likely overestimated the potential future risks to McCoy Creek from chromium. This is because U.S. EPA based the concentration for chromium on an analysis for total chromium. However, the GSI criteria U.S. EPA used in its comparison is for hexavalent chromium, which is generally a less stable form of chromium.

Conclusions
Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare or the environment.

8. REMEDIAL ACTION OBJECTIVES

U.S. EPA's remedial action objectives for the off-property groundwater contamination are to:

1) Return the off-property groundwater to its expected beneficial use as a supply of drinking water by restoring the groundwater to drinking water standards for TCE and vinyl chloride within a reasonable time frame for this site;

2) Prevent or minimize further migration of the contaminated groundwater plume (plume containment);

3) Prevent people from using the contaminated groundwater as a drinking water supply until the groundwater is restored;

4) Ensure that the level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D does not pose any unacceptable health risks; and

5) Ensure that the levels of chromium, copper and zinc that were detected in the off-property groundwater above background concentrations near-the site will not affect McCoy Creek as the groundwater flows away from the site and discharges into the creek;

These remedial action objectives are U.S. EPA's final remedial action objectives for off-property groundwater. U.S. EPA developed these objectives to address the potential future risks U.S. EPA identified for the off-property groundwater in its streamlined risk evaluation. These risks include the potential future residential use of off-property groundwater as a drinking water supply and further migration of the contaminated plume. U.S. EPA's remedial action objectives also address the level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D. Finally, the remedial objectives address the potential future ecological risks that could be posed to McCoy Creek if the levels of chromium, copper and zinc detected in the off-property groundwater contamination above background levels in monitoring wells near the site moved with the groundwater and discharged into McCoy Creek at levels that would threaten the creek.

As discussed in Section 7, Summary of Site Risks, no one is using the contaminated groundwater for drinking water, and there are no current risks to human health from the inhalation of basement vapors or from the recreational use of McCoy Creek. U.S. EPA also did not identify any current ecological impacts to McCoy Creek from the off-property groundwater.

The federal and state drinking water standard for trichloroethene is 5 ppb and 2 ppb for vinyl chloride. The Michigan Part 31 generic GSI criteria for TCE is 200 ppb and 15 ppb for vinyl chloride. For metals, the Michigan Part 31 generic GSI is 11 for hexavalent chromium, and the Michigan generic final chronic values, which U.S. EPA calculated assuming 100 mg/L CaCo3, are 74 ppb for trivalent chromium, 9 ppb for copper and 118 ppb for zinc, or background.

9. DESCRIPTION OF ALTERNATIVES

U.S. EPA evaluated three remedial alternatives to address the off-property groundwater contamination at the Electro-Voice site. These alternatives were developed based on the off-property groundwater components identified and evaluated for each of the remedial alternatives in the 1991 FS. The three alternatives are:

1) No Further Action
2) Monitored Natural Attenuation
3) Groundwater Pump and Treat.

Alternative 1 - No Further Action

Remedy Components: None. This alternative does not involve any cleanup action or cleanup requirements for off-property groundwater. Chemical concentrations in the groundwater are expected to decrease over time due to the natural processes of stream capture, dilution and biodegradation.

Common Elements and Distinguishing Features: The natural processes affecting the off-property groundwater would be the same as the natural processes in Alternative 2 - Monitored Natural Attenuation. However, unlike the monitored natural attenuation alternative, the no further action alternative does not include institutional controls, monitoring or contingency actions. Applicable or Relevant and Appropriate Requirements (ARARs) would not apply and the groundwater would not required to attain cleanup standards or meet cleanup objectives. U.S. EPA cannot determine the long-term reliability this alternative since this alternative does not include any requirements for institutional controls or monitoring.

Expected Outcomes: Chemical concentrations would eventually decrease to drinking water levels over time. However, U.S. EPA would not be able to confirm or evaluate the expected outcome since this alternative does not include monitoring,

Estimated Capital Cost: $0
Estimated Annual Operation and Maintenance (O&M) Costs: $0
Estimated Present Worth: $0
Estimated Time to Construct: 0
Estimated Time Until Off-Property Groundwater Cleaned Up to Drinking Water Levels for TCE and vinyl chloride: 53 to 66 years

Discussion: The no further action alternative does not involve any cleanup action or cleanup requirements for off-property groundwater. However, since the source of the off-property groundwater contamination has been addressed through previous cleanup actions (the lagoons, drywell area and on-property groundwater), U.S. EPA expects the concentrations of TCE and vinyl chloride in the off-property groundwater to naturally decrease, or attenuate, improving groundwater quality over time. The primary attenuation processes affecting the off-property groundwater at the Electro-Voice site are stream capture and dilution, with some biodegradation.

Electro-Voice's quarterly and annual groundwater monitoring since 1993 and the 1998 off-property groundwater investigation indicate that TCE concentrations in the groundwater have already decreased from a maximum of 39 to 60 ppb in 1993 to a maximum of 26 ppb in 1998. The monitoring and the 1998 investigation also show that McCoy Creek is capturing the groundwater contaminants and that the area of groundwater contamination is not getting significantly wider or spreading beyond about the intersection of Third Street and Red Bud

Trail, about 500 feet north of McCoy Creek. Also, vinyl chloride, an expected degradation product of TCE and cis-1,2-DCE that is more toxic than the parent compounds, continues to be isolated to MW-30, and has only been intermittently detected at low levels (0.1 ppb to 0.5 ppb) in two other wells (MW-14 and MW-28).

However, the no further action alternative does not include institutional controls to prevent exposure to the contaminated groundwater until the groundwater quality improves; monitoring to track the progress and effectiveness of natural attenuation; or contingency actions. Existing institutional controls may be effective in preventing or minimizing potential future exposure to contaminated groundwater, however, U.S. EPA would not require or monitor these controls. Existing institutional controls at Electro-Voice include the availability of the city water supply, deed restrictions on about half of the properties within the off-property groundwater contamination, and Buchanan's local ordinance which prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated. The law requires U.S. EPA to evaluate this a no action alternative to give the agency a basis for comparison.

Alternative 2 - Monitored Natural Attenuation

Remedy Components: Natural attenuation via stream capture and dilution with some biodegradation, institutional controls, monitoring, and contingency actions.

Common Elements and Distinguishing Features: Natural attenuation processes would be the same as those occurring under Alternative 1 - No Further Action. However, the monitored natural attenuation alternative also includes institutional controls, monitoring and contingency actions. Key ARARs are:

- Safe Drinking Water Act MCLs;
- Michigan Act 451 Part 201 generic residential drinking water criteria;
- Michigan Act 451 Part 31 GSI criteria; and
- Michigan Act 451 Part 201 requirements for institutional controls.

The institutional controls, monitoring and contingency actions make the long-term reliability of this alternative high.

Expected Outcomes: Groundwater is returned to drinking water levels in approximately 53 to 66 years. People are prevented from drinking the contaminated groundwater until the cleanup levels are attained. Monitoring and contingency actions ensure that contaminant concentrations are decreasing and that the area of the off-property groundwater contamination does not expand significantly or impact well supplies.

Estimated Capital Cost: $3,000
Estimated Annual Operation and Maintenance (O&M) Costs: $15,100
Estimated Present Worth: $145,000
Estimated Time to Construct: 1 to 2 weeks
Estimated Time Until Off-Property Groundwater Cleaned Up to Drinking Water Levels for TCE and vinyl chloride: 53 to 65 years

Discussion: This alternative relies on natural processes including recharge, stream capture, dilution, dispersion and intrinsic biodegradation to reduce the chemical concentrations in the groundwater to cleanup levels and return the aquifer to its potential use as a drinking water supply. Because the sources of the off-property groundwater contamination (the lagoons, the drywell area and on-property groundwater) have been addressed through previous cleanup actions, U.S. EPA expects the concentrations of TCE and vinyl chloride in the off-property groundwater to naturally decrease, or attenuate, improving groundwater quality over time. The primary attenuation processes affecting the off-property groundwater at the Electro-Voice site are stream capture and dilution, with some biodegradation.

Electro-Voice's quarterly and annual groundwater monitoring since 1993 and the 1998 off-property groundwater investigation indicate that TCE concentrations in the groundwater have already decreased from a maximum of 39 to 60 ppb in 1993 to a maximum of 26 ppb in 1998. The monitoring and the 1998 investigation also show that McCoy Creek is capturing the groundwater contaminants and that the area of groundwater contamination is not getting significantly wider or spreading beyond about the intersection of Third Street and Red Bud Trail, about 500 feet north of McCoy Creek. Also, vinyl chloride, an expected degradation product of TCE and cis-1,2-DCE that is more toxic than the parent compounds, continues to be isolated to MW-30, and has only been intermittently detected at low levels (0.1 ppb to 0.5 ppb) in two other wells (MW-14 and MW-28).

Once the chemicals in the off-property groundwater enter McCoy Creek, they mix with the creek water and either volatilize or become so diluted they are harmless. Modeling calculations of site conditions indicates that it will take approximately 53 to 66 years for the off-property groundwater to naturally attenuate to drinking water levels. U.S. EPA expects a cleanup time frame of approximately 53 to 66 years for the off-property groundwater to be reasonable at this site since U.S. EPA does not expect the groundwater contamination to migrate significantly beyond its present boundaries and because U.S. EPA does not anticipate that the off-property groundwater will be utilized as a source of drinking water in the foreseeable future.

All Buchanan residents except one are connected to the municipal water supply. The city wells, the private well in Buchanan, and private wells northwest and east of Buchanan are either upgradient or side gradient of the off-property groundwater contamination and are not likely to become contaminated by the off-property groundwater contamination. Also, an adequate groundwater supply is available.

In 1996 the City of Buchanan also adopted a local ordinance (Chapter 38, Article IV, Sections 38-90 to 38-93) that prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated. The city has also drafted a new ordinance intended to be consistent with the requirements for institutional controls in Michigan Act 451, Natural Resources and Environmental Protection Act Part 201. The city is in the process of implementing the new ordinance and revising the boundaries of the restricted area to incorporate the additional data collected during Electro-Voice's 1998 off-property groundwater investigation.

About one-half of the properties within the area of groundwater contamination also have deed restrictions prohibiting the installation of drinking water wells on the property. These deed restrictions were obtained by Electro-Voice as part of the RA for OU1.

Additional information about the modeling used to estimate the cleanup time frames for the monitored natural attenuation alternative and the other alternatives is provided in Appendix B of the 1991 FS and the December 1991 modeling recalculations, which are included in this ROD as Attachment 3.

The major components of the monitored natural attenuation alternative are:

Institutional Controls: Institutional controls would prevent people from using the off-property groundwater until the cleanup levels are attained. Existing institutional controls include the availability of the city water supply, deed restrictions on about half of the properties within the area of off-property groundwater contamination, and Buchanan's local ordinance that prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated.

Monitoring: Monitoring would track the progress of natural attenuation over time and would identify changes in land and groundwater use and changes in groundwater conditions that could affect the performance or the protectiveness of the remedy. The monitoring would also ensure that:

- The remedy remains protective of human health and the environment until the groundwater is returned to drinking water levels;
- The level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D does not pose any unacceptable health risks; and
- The levels of chromium, copper and zinc detected above background levels and Michigan GSI criteria or calculated final chronic GSI values in near-property groundwater will not affect McCoy Creek as the groundwater discharges into the creek.

Contingency Actions: Contingency actions would be implemented if monitoring identifies the need for modifications or changes in the remedy. Possible contingency actions could include:

- Confirmation sampling;
- Collecting groundwater samples more frequently;
- Collecting surface water and/or sediment samples from McCoy Creek;
- Installing new monitoring wells;
- Pursuing additional deed restrictions;
- Notifying the City of Buchanan that the city should revise the restricted area in the local ordinance;
- Evaluating whether McCoy Creek or any drinking water supplies are threatened and whether additional response actions, such as the construction of a groundwater containment system or a treatment system are necessary; and
- Implementing additional response actions, such as a groundwater containment system or a treatment system as necessary to protect human health and the environment and to return the off-property groundwater to a drinking water supply within a time frame that is reasonable based on the conditions at this site. This time frame is approximately 53 to 66 years.

The capital costs for this alternative are for the installation of 2 to 4 additional groundwater monitoring wells to supplement the existing monitoring well network (if necessary).

Alternative 3 - Groundwater Pump and Treat

Remedy Components: Extraction wells, groundwater treatment unit, institutional controls, monitoring, and contingency actions.

Common Elements and Distinguishing Features: The groundwater pump and treat alternative uses engineered technologies to extract and treat contaminated groundwater to cleanup levels instead of relying on natural processes. Like Alternative 2 - Monitored Natural Attenuation, this alternative includes institutional controls, monitoring and contingency actions. Key ARARs are:

- Safe Drinking Water Act MCLs;
- Michigan Act 451 Part 201 generic residential drinking water criteria;
- Michigan Act 451 Part 31 GSI criteria;
- National Pollutant Discharge Elimination System (NPDES) requirements; and
- Clean Air Act requirements and Resource Conservation and Recovery Act (RCRA) requirements.

The engineered components of this technology, combined with institutional controls, monitoring and contingency actions make the long-term reliability of this alternative high.

Expected Outcomes: Groundwater is returned to drinking water levels in 35 to 42 years. People are prevented from drinking the contaminated groundwater until the cleanup levels are attained. Monitoring and contingency actions ensure that the pump and treat system effectively contains the off-property groundwater contamination and is reducing contaminant concentrations.

Estimated Capital Cost: $400,000
Estimated Annual Operation and Maintenance (O&M) Costs: $90,000
Estimated Present Worth: $1.3 million
Estimated Time to Construct: 4 months
Estimated Time Until Off-Property Groundwater Cleaned Up to Drinking Water Levels for TCE and vinyl chloride: 35 to 42 years

Discussion: The groundwater pump and treat alternative involves installing five collection wells just south of McCoy Creek to capture the off-property groundwater and to prevent it from migrating into the creek. This alternative would treat the collected groundwater using a presumptive treatment technology such as activated carbon, air stripping, chemical oxidation/reduction or photolysis/oxidation. The treated groundwater would be discharged to either a publicly owned treatment works or McCoy Creek. Discharges to McCoy Creek would be required to meet the substantive requirements of a National Pollutant Discharge Elimination System permit. Any off-gas from an air stripping tower would be treated using vapor phase activated carbon. The final number and the locations of the collection wells would be determined during the remedial design. The treatment residuals (e.g., spent carbon) would be managed and disposed of in accordance with Resource Conservation and Recovery Act (RCRA) requirements.

Estimates indicate that it would take approximately 35 to 42 years for the pump and treat system to cleanup the off-property groundwater to drinking water levels. Additional information about the modeling used to estimate the cleanup time frames for the groundwater pump and treat alternative and the other alternatives is provided in Appendix B of the FS and the December 1991 modeling recalculations, which are included in this ROD as Attachment 3.

The groundwater pump and treat alternative also includes:

- The same institutional controls to prevent people from using the off-property groundwater until the cleanup levels are attained as in Alternative 2 - Monitored Natural Attenuation;

- Monitoring to track and evaluate the effectiveness of the pump and treat system; and

- Contingency actions in the event of system failures or if the monitoring identifies the need for modifications to the pumping rate(s), changes in the restricted area for institutional controls, or changes to the monitoring plan.

10. COMPARATIVE ANALYSIS OF ALTERNATIVES

U.S. EPA evaluated the relative performance of each remedial alternative in the 1991 FS and below using the nine criteria set forth in the NCP at 40 C.F.R. §300.430. From this evaluation, U.S. EPA determines which alternative provides the "best balance" of trade-offs with respect to the evaluation criteria and the other alternatives.

Threshold Criteria

The following two criteria, overall protection of human health and the environment, and compliance with Applicable or Relevant and Appropriate Requirements (ARARs) are threshold criteria that must be met in order for U.S. EPA to select an alternative.

1. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced or controlled through treatment, engineering controls and/or institutional controls.

The no further action alternative (Alternative 1) does not meet the requirement for overall protection of human health and the environment. U.S. EPA expects chemical concentrations in the groundwater to naturally decrease over time. However, the no further action alternative does not include institutional controls, monitoring programs or contingency actions.

Alternative 2 (monitored natural attenuation) and Alternative 3 (groundwater pump and treat) protect human health and the environment by eliminating, reducing or controlling the risks posed by the off-property groundwater contamination.

The monitored natural attenuation alternative protects human health and the environment by using natural processes such as recharge, stream capture, dilution, dispersion and degradation to reduce chemical concentrations in the groundwater to drinking water levels and to minimize further spreading of the contaminant plume. McCoy Creek will capture groundwater contaminants, where they will become harmless and will not contaminate drinking water supplies. The monitored natural attenuation alternative also includes institutional controls to prevent people from using the off-property groundwater until the cleanup levels are attained; monitoring to track and evaluate the effectiveness of natural attenuation and to ensure its protectiveness over time; and contingency actions to be implemented in the event that the remedy is not performing as anticipated or if site conditions change to the extent that the natural attenuation alternative is no longer protective.

The groundwater pump and treat alternative provides protection to human health and the environment by using an engineered system to actively pump and treat contaminated groundwater and to return the off-property groundwater to drinking water levels. The groundwater pump and treat alternative would also contain groundwater contaminants and prevent them from flowing into McCoy Creek. The groundwater pump and treat alternative also includes institutional controls, monitoring and contingency actions.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites comply with legally applicable or relevant and appropriate federal and state requirements, standards, criteria and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address hazardous substances, the remedial action to be implemented at a site, the location of the site or other circumstances present at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria or limitations promulgated under federal or state law which, while not applicable to the hazardous materials found at a site, the remedial action, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes or provides a basis for invoking a waiver.

Table 7 summarizes the ARARs that U.S. EPA identified as being applicable or relevant and appropriate for the remedial action at the Electro-Voice site. Because the no-action alternative does not involve conducting any remedial action at the site, an ARARs analysis is not necessary for Alternative 1.

U.S. EPA expects the monitored natural attenuation alternative (Alternative 2) and the groundwater pump and treat alternative (Alternative 3) to comply with all ARARs. These alternatives involve remediation activities and are expected to comply with Michigan Act 451 Part 201 (Environmental Response) and Part 31 (GSI). Alternatives 2 and 3 involve construction or other sampling activities and are expected to comply with the Occupational Safety and Health Act (OSHA). Alternatives 2 and 3 involve engineered or natural processes to address groundwater contamination and are expected to comply with the Safe Drinking Water Act (SDWA) and Michigan Act 451 Part 201 (Environmental Response). Both alternatives have the potential to generate non-hazardous solid waste (e.g., construction debris or non-hazardous soil debris) and are expected to comply with the Resource Conservation and Recovery Act regulations for solid waste disposal and Michigan Act 451 Part 115 (Solid Waste Management).

Additionally, Alternative 3 may also involve the generation and storage of hazardous waste (e.g., spent carbon); the production of air emissions; discharges to a surface water body; and construction involving excavation. This alternative is also expected to comply with the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), the Clean Water Act (CWA), and Michigan Act 451 Part 111 (Hazardous Waste Management), Part 121 (Liquid Industrial Waste), Part 31 (Water Resources Protection), Part 55 (Air Resources Protection), Part 625 (Mineral Wells) and Part 91 (Soil Erosion and Control).

Primary Balancing Criteria

The remaining seven criteria are primary balancing criteria.

3. Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

The no further action alternative (Alternative 1) does not provide long-term effectiveness and permanence. U.S. EPA expects chemical concentrations in the groundwater to attenuate naturally over time. However, future rates of attenuation are uncertain and may not continue. This alternative does not require any cleanup levels or include monitoring or contingency actions to ensure the effectiveness of this alternative.

Alternatives 2 and 3 (monitored natural attenuation and groundwater pump and treat) provide long-term effectiveness and permanence by using natural or hydraulic processes to permanently remove groundwater contaminants from the groundwater and/or to permanently disperse groundwater contaminants or transform them into less-toxic chemicals. These alternatives return the contaminated off-property groundwater to its use as a drinking water supply and offer a high degree of long-term effectiveness and permanence.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. This criterion addresses U.S. EPA's statutory preference for selecting remedial actions which include, as a principal element, treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants.

Under current conditions and the conditions observed in the off-property groundwater since 1993, the no further action alternative (Alternative 1) and the monitored natural attenuation alternative (Alternative 2) provide for some reduction of toxicity, mobility or volume through natural treatment processes, since the presence of cis-1,2-DCE and vinyl chloride indicate that some of the off-property groundwater contaminants are degrading. However, this degree of biodegradation is not significant. Also, under the no further action alternative, the effects of these natural processes could not be verified since there would not be any monitoring.

The groundwater pump and treat option provides a high level of reduction in toxicity, mobility or volume through treatment by collecting and actively treating all groundwater contaminants.

5. Short-Term Effectiveness

Short-term effectiveness considers the time it takes to implement a remedy; the time to reach cleanup objectives; and the risks an alternative may pose to site workers, the community, and the environment while the remedy is being implemented and until the cleanup goals are attained.

The no further action alternative (Alternative 1) would not be effective in the short-term since this alternative does not include institutional controls to prevent people from using the off-property groundwater until the groundwater quality improves; monitoring to track and evaluate the effectiveness of the natural processes and to ensure their protectiveness over time; or contingency actions to be implemented in the event that the natural processes are not performing as anticipated or if site conditions change to the extent that the natural processes are no longer protective.

The groundwater pump and treat alternative (Alternative 3) is slightly more effective than the monitored natural attenuation alternative (Alternative 2) in the short-term since it would clean up the contaminated groundwater in about two-thirds as much time as the monitored natural attenuation alternative - 35 to 42 years for groundwater pump and treat compared to 53 to 66 years for monitored natural attenuation. However, the short-term risks to the community that are common to both alternatives (e.g., exposure to contaminated groundwater) would be minimized by institutional controls to prevent people from using the off-property groundwater until the cleanup levels are attained; monitoring to track and evaluate the effectiveness of the remedy and to ensure its protectiveness over time; and contingency actions to be implemented in the event that the remedy is not performing as anticipated or is no longer protective.

The groundwater pump and treat alternative and the monitored natural attenuation alternative also pose some short-term risks to workers during the implementation and the operation of the remedy, but these risks are manageable through proper health and safety practices. Potential environmental impacts for the groundwater pump and treat alternative and the monitored natural attenuation alternative would be minimized by compliance with air emissions, water discharge limits and solid waste regulations. The no further action alternative does not include any response actions and, therefore, does not pose any short-term risks from implementation.

6. Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as the availability of services and materials, administrative feasibility and coordination with other governmental entities are also considered.

The no further action alternative (Alternative 1) is technically and administratively feasible because it would only require a cessation of current monitoring activities and the proper abandonment of existing monitoring wells. The monitored natural attenuation alternative (Alternative 2) is readily implementable. There is already an existing network of monitoring wells in the area of off-property groundwater contamination and any new monitoring wells should not be difficult to install. Also, institutional controls including the availability of the city water supply, a local ordinance prohibiting contaminated groundwater from being used as a drinking water supply, and deed restrictions on many properties are already in place.

The equipment for the groundwater pump and treat system (Alternative 3) is commonly used and readily available. However, this alternative is slightly more difficult to implement than monitored natural attenuation. The pump and treat alternative would require access or easements for the five wells south of McCoy Creek, the treatment unit and the pipes. The pump and treat system would also have to comply with either the substantive requirements for an NPDES permit or any pre-treatment requirements from the publicly owned treatment works, air emissions requirements and solid and hazardous waste regulations.

7. Cost

Cost includes estimated capital and operation and maintenance costs as well as present worth costs. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a rage of +50 to -30 percent.

Minor costs would be incurred with the no further action alternative (Alternative 1) to properly abandon existing off-property groundwater monitoring wells. The present worth cost of the monitored natural attenuation alternative (Alternative 2) is $145,000. This cost is significantly less than the present worth cost for the groundwater pump and treat alternative (Alternative 3) which is $1.3 million. Based on current conditions and the conditions observed in off-property groundwater since 1993, the availability of the municipal water supply and institutional controls such as the city ordinance, the increased cost of the groundwater pump and treat alternative provides only slightly more protection than the monitored natural attenuation alternative.

8. <u>State Acceptance</u>

State acceptance considers whether the State of Michigan agrees with U.S. EPA's analysis and the selected remedy for the off-property groundwater contamination.

The State of Michigan has indicated that it is considering concurring with the selection of Alternative 2 - Monitored Natural Attenuation as the remedy for off-property groundwater at the Electro-Voice site. If the State of Michigan does concur, the State will provide U.S. EPA with a letter of concurrence, which will be attached to this ROD as Appendix B.

9. <u>Community Acceptance</u>

Community acceptance considers whether the local community agrees with U.S. EPA's analysis and recommended alternative. Comments received on U.S. EPA's proposed cleanup plan are an important indicator of community acceptance.

U.S. EPA received three comments on the proposed plan during the public comment period. One comment was from a resident who complained about the poor condition Electro-Voice left her grandson's property in after constructing the clay cap over the lagoons, but did not have any comments on the proposed remedy for off-property groundwater. The second comment was from a Buchanan city commissioner who thought that the longer cleanup time frame for the monitored natural attenuation alternative was unreasonable; was concerned about impacts to McCoy Creek and the St. Joseph River; and expressed his preference for the groundwater pump and treat alternative. The last comment was from Mark IV's engineering consultants who supported U.S. EPA's proposed plan and commented on the calculation of the cleanup time frames. U.S. EPA did not receive any other comments on the proposed plan.

The comments received during the public comment period and U.S. EPA's responses to the comments are described in the Responsiveness Summary which is included in the ROD as Appendix A.

11. THE SELECTED REMEDY

The ultimate objective for the off-property groundwater contamination is to return the contaminated groundwater to its beneficial use as a supply of drinking water. The off-property groundwater could be used as a future source of drinking water, but it is not currently being used for this purpose. Two separate lines of evidence indicate that monitored natural attenuation would be successful in attaining the remedial objectives for the off-property groundwater. They are:

1) Information collected during the RI; six years of groundwater monitoring data; and Electro-Voice's 1998 investigation. These data show that COC concentrations are

declining; that McCoy Creek is capturing groundwater contaminants; and that the boundaries of the plume are expected to remain relatively stable over time; and

2) Predictive modeling conducted during the FS and recalculated in 1991.

Based on these lines of evidence, and after a careful analysis of all the remedial alternatives for off-property groundwater, U.S. EPA believes that the selected remedy, Alternative 2 - Monitored Natural Attenuation, will achieve this objective in a reasonable time frame for this site.

Monitored natural attenuation will return the contaminated off-property groundwater to its beneficial use as a supply of drinking water. Current estimates indicate that the area of off-property groundwater contamination will attain cleanup levels within approximately 53 to 66 years. The cleanup levels for the off-property groundwater COCs are specified in Table 8. This cleanup time frame of approximately 53 to 66 years is slightly longer than the cleanup time frame of 35 to 42 years estimated for Alternative 3, which involves pumping and treating the contaminated off-property groundwater. Additional information concerning the predictive models used for these estimates is provided in Appendix B of the 1991 FS and the December 1991 modeling recalculations, which are included in this ROD as Attachment 3.

Although the estimated time for natural processes to attain remediation objectives is slightly longer than that required for the groundwater pump and treat alternative, U.S. EPA considers an approximate time frame of 53 to 66 years to be reasonable for this site because there is no anticipated need for the contaminated groundwater within this period (see Section 6, Current and Potential Future Site and Resource Uses).

In addition to the modeling estimates, the concentration levels for the COCs have decreased since the source control measures for the drywell area and lagoons were implemented in 1993 to 1997. This trend of declining contaminant levels has been confirmed by Electro-Voice's six years of quarterly groundwater monitoring. This monitoring data indicates that the source control measures have been effective and reduces the uncertainty of the modeling predictions.

Remedy Components

The primary components of the monitored natural attenuation remedy include:

Natural Attenuation: Natural attenuation will restore the off-property groundwater to MCLs and Michigan Act 451 Part 201 generic residential drinking water criteria for TCE and vinyl chloride. The sources of the off-property groundwater contamination (the lagoons, the drywell area and on-property groundwater) were addressed through previous cleanup actions, and U.S. EPA expects the concentrations of TCE and vinyl chloride remaining in the off-property groundwater to naturally decrease, or attenuate, improving groundwater quality over time. The primary attenuation processes affecting the off-property groundwater are stream capture and dilution, with some biodegradation.

Electro-Voice's quarterly and annual groundwater monitoring conducted since 1993 and the 1998 off-property groundwater investigation indicate that TCE concentrations in the groundwater have already decreased from a maximum of 39 to 60 ppb in 1993 to a maximum of 26 ppb in 1998. Electro-Voice's monitoring and the 1998 investigation also show that McCoy Creek is capturing the groundwater contaminants and that the area of groundwater contamination is not getting significantly wider or spreading beyond about the intersection of Third Street and Red Bud Trail, about 500 feet north of McCoy Creek. Also, vinyl chloride, an expected degradation product of TCE and cis-1,2-DCE that is more toxic than the parent compounds, continues to be isolated to MW-30, and has only been intermittently detected at low levels (0.1 ppb to 0.5 ppb) in two other wells (MW-14 and MW-28).

Once the chemicals in the off-property groundwater enter McCoy Creek, they mix with the creek water and either volatilize or become so diluted they are harmless. Modeling calculations of site conditions during the 1991 FS and the December 1991 modeling recalculations indicates that it will take approximately 53 to 66 years for the off-property groundwater to naturally attenuate to drinking water levels. U.S. EPA expects a cleanup time frame of approximately 53 to 66 years for the off-property groundwater to be reasonable at this site since U.S. EPA does not expect the contamination to migrate significantly beyond its present boundaries, and because U.S. EPA does not anticipate that anyone will use the off-property groundwater as a source of drinking water in the foreseeable future.

The city wells are located about three-fourths of a mile west of Electro-Voice and are either upgradient or side gradient of the off-property groundwater contamination. The city wells are not in danger of becoming contaminated by the off-property groundwater contamination. The private well in Buchanan and the private wells northwest and east of Buchanan are one-third to three-fourths of a mile side-gradient to the off-property groundwater contamination and are also not likely to be impacted by off-property groundwater contaminants.

Institutional Controls: Institutional controls will limit groundwater use until the aquifer is restored to cleanup levels. The City of Buchanan currently has a local ordinance (Chapter 38, Article IV, Sections 38-90 to 38-93) that prohibits the installation of drinking water wells in areas designated by state or federal agencies as contaminated. The city has also drafted a new ordinance intended to be consistent with the requirements for institutional controls in Michigan Act 451, Natural Resources and Environmental Protection Act Part 201. The city is in the process of implementing the new ordinance and revising the boundaries of the restricted area to incorporate the additional data collected during Electro-Voice's 1998 off-property groundwater investigation.

Electro-Voice was also able to obtain deed restrictions prohibiting the installation of drinking water wells for about one-half of the properties within the area of groundwater contamination. Electro-Voice obtained these deed restrictions as part of the RA for OU1. Although Electro-Voice could not obtain deed restrictions for the other properties within the area of off-property groundwater contamination, additional deed restrictions are not necessary because the city ordinance already prohibits people from using the contaminated groundwater as a drinking supply.

All Buchanan residents except one are connected to the municipal water supply. The city wells, the private well in Buchanan, and private wells northwest and east of Buchanan are either upgradient or side gradient of the off-property groundwater contamination. None of these wells are likely to become contaminated by the off-property groundwater contamination. A copy of Buchanan ordinance Chapter 38, Article IV, Sections 38-90 to 38-93, a copy of the draft revised ordinance and a copy of one of the deed restrictions are provided in Attachment 2.

Monitoring: U.S. EPA will carefully monitor the actual performance of the natural attenuation remedy in accordance with a monitoring plan that will be developed during the remedial design. Some potential components for the monitoring plan (e.g., possible sampling frequency and potential monitoring well network) are discussed in Attachment 4. Also, a new monitoring well will be installed and sampled on the south/east side of McCoy Creek between staff gauges MC-7 and MC-8. The information collected from this well will be used to verify the northeast extent of the groundwater contamination and to confirm the full venting of groundwater contaminants to McCoy Creek in this area.

The monitoring will track the progress of natural attenuation over time and identify changes in land and groundwater use and changes in groundwater conditions that could affect the performance or the protectiveness of the remedy. The monitoring will also ensure that:

- The remedy remains protective of human health and the environment until the groundwater is returned to drinking water levels for TCE and vinyl chloride;

- The level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D does not pose any unacceptable health risks; and

- The levels of chromium, copper and zinc detected above background levels and Michigan GSI criteria or calculated final chronic GSI values in near-property groundwater will not affect McCoy Creek as the groundwater discharges into the creek.

U.S. EPA will reconsider the remedy decision if the monitoring data indicates that contaminant levels are not continuing to decline as estimated in the modeling predictions. One or more of the following observations could lead to U.S. EPA reconsidering the remedy, if confirmed by three or more rounds of sampling:

- Concentration levels of TCE, cis-1,2-DCE, vinyl chloride, chromium, copper or zinc are increasing, indicating that other site-related sources may be present.

- Concentration levels of TCE, cis-1,2-DCE or vinyl chloride are not decreasing at a rate that will return the aquifer to drinking water levels in approximately 53 to 66 years, or differ significantly from modeling predictions.

- Site-related concentration levels of TCE, cis-1,2-DCE or vinyl chloride are increasing and may pose a threat to McCoy Creek.

- The level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D poses an unacceptable health risk or the levels of chromium, copper and zinc detected above background levels and Michigan GSI criteria or calculated final chronic GSI values in near-property groundwater pose a threat to McCoy Creek as the groundwater discharges into the creek.

- The contaminant plume for TCE, cis-1,2-DCE or vinyl chloride increases significantly in areal or vertical extent and/or volume from that predicted by modeling estimates or as expected based on the groundwater monitoring conducted 1993 to 1998 and the 1998 off-property groundwater investigation.

- Changes in land or groundwater use or changes in groundwater conditions that could affect the performance or the protectiveness of the remedy occur.

Contingency Actions: Contingency actions will be implemented if the monitoring identifies the need for modifications or changes in the remedy. Possible contingency actions could include:

- Confirmation sampling;
- Collecting groundwater samples more frequently;
- Collecting surface water and/or sediment samples from McCoy Creek;
- Installing new monitoring wells;
- Pursuing additional deed restrictions;
- Notifying the City of Buchanan that the city should revise the restricted area in the local ordinance;
- Evaluating whether McCoy Creek or any drinking water supplies are threatened and whether additional response actions, such as the construction of a groundwater containment system or a treatment system are necessary; and
- Implementing additional response actions, such as a groundwater containment system or a treatment system as necessary to protect human health and the environment and return the off-property groundwater to a drinking water supply within a time frame that is reasonable based on the conditions at this site. This time frame is approximately 53 to 66 years.

Cost Estimate

The cost estimate for monitored natural attenuation was developed in the 1991 FS (as a component of FS alternative 3A) and is shown below. The capital costs are for the installation of 2 to 4 additional groundwater monitoring wells to supplement the existing monitoring well network (if necessary). The annual O&M costs are based on semi-annual monitoring and are for sample collection, equipment, laboratory analysis, data review and annual data review. The discount rate used in calculating the present worth cost is 10 percent.

Estimated Capital Cost: $3,000
Estimated Annual O&M Costs: $15,100
Estimated Present Worth: $145,000

Estimated Outcomes of the Selected Remedy

The estimated outcomes of the selected remedy are to return contaminated off-property groundwater to a supply of drinking water in approximately 53 to 66 years. The final cleanup levels are 5 ppb for TCE and 2 ppb for vinyl chloride. These levels are based on MCLs and Michigan Act 451 Part 201 generic residential drinking water criteria.

The selected remedy will prevent people from drinking the contaminated groundwater until the cleanup levels are attained. Monitoring and contingency actions will also ensure that contaminant concentrations in the groundwater are decreasing and that the area of off-property groundwater contamination does not expand significantly or impact well supplies. The monitoring will also ensure that any increases in the levels of TCE, cis-1,2-DCE or vinyl chloride are not adversely affecting McCoy Creek as the groundwater flows into the creek.

The selected remedy will also ensure that the level of zinc detected above background levels and Michigan generic residential drinking water criteria in MW-18D does not pose any unacceptable health risks, and that the levels of chromium, copper and zinc detected above background levels and Michigan GSI criteria or calculated final chronic GSI values in near-property groundwater are not migrating toward McCoy Creek at levels that would adversely affect the creek.

12. STATUTORY DETERMINATIONS

Under CERCLA § 121 and the National Contingency Plan, 40 C.F.R. Part 300, U.S. EPA must select remedies that: protect human health and the environment; comply with applicable or relevant and appropriate requirements, unless a statutory waiver is justified; are cost-effective; and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element. CERCLA also has a bias against off-site disposal of untreated wastes. This section discusses how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy, Alternative 2, will protect human health and the environment through: natural attenuation processes, including stream capture, dilution and biodegradation; institutional controls; monitoring; and, if necessary, contingency actions.

Electro-Voice's quarterly and annual groundwater monitoring since 1993 and the 1998 off-property groundwater investigation indicate that TCE concentrations in the groundwater have already decreased from a maximum of 39 to 60 ppb in 1993 to a maximum of 26 ppb in 1998. The ongoing monitoring and the 1998 investigation also show that McCoy Creek is capturing the groundwater contaminants and that the area of groundwater contamination is not getting significantly wider or spreading beyond about the intersection of Third Street and Red Bud Trail, about 500 feet north of McCoy Creek. Also, vinyl chloride, an expected degradation product of TCE and cis-1,2-DCE that is more toxic than the parent compounds, continues to be isolated to MW-30, and has only been intermittently detected at low concentrations (0.1 ppb to 0.5 ppb) in two other wells (MW-14 and MW-28).

Once the chemicals of concern in the off-property groundwater enter McCoy Creek, they mix with the creek water and either volatilize or become so diluted that they are harmless. Modeling calculations of site conditions during the 1991 FS and the December 1991 modeling recalculations indicate that it will take approximately 53 to 66 years for the off-property groundwater to naturally attenuate to drinking water levels. U.S. EPA expects a cleanup time frame of 53 to 66 years for the off-property groundwater to be reasonable at this site. U.S. EPA expects this because U.S. EPA does not expect the contamination to migrate significantly beyond its present boundaries and because U.S. EPA does not expect that anyone will use the off-property groundwater as a source of drinking water in the foreseeable future.

Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy, Alternative 2, complies with all ARARs. This ROD presents the ARARs in Section 9, Section 10.3, this section and in Table 7. Chemical-, location- and action-specific ARARs include:

- Michigan Act 451, Part 201 (Environmental Response), which addresses environmental response actions.

- Michigan Act 451, Part 31 (Groundwater-Surface Water Interface (GSI)), which addresses acceptable concentration levels in groundwater that discharges to surface water.

- Safe Drinking Water Act (SDWA), 42 U.S.C. §§ 300f-300j-11, which addresses acceptable concentration levels in groundwater that serves as a potential drinking water aquifer.

- Clean Water Act (CWA), 33 U.S.C. §§ 1251-1387, which addresses acceptable concentration levels in surface water.

- Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901-6991i, which addresses generation and disposal of solid waste, both hazardous and non-hazardous.

- Michigan Act 451, Part 111 (Hazardous Waste Management), which addresses generation and disposal of solid hazardous waste.

- Michigan Act 451, Part 115 (Solid Waste Management), which addresses generation and disposal of solid non-hazardous waste.

- Occupational Safety and Health Act (OSHA), which addresses worker safety during construction, sampling and other activities.

Michigan Administrative Rule 299.5705(5) of Act 451 Part 201 indicates that unless a waiver has been granted, the horizontal and vertical extent of hazardous substances is not to increase after the initiation of remedial activities. Part 201 of Act 451 at Section 324.20118(5) permits implementation of a remedy that does not comply with Administrative Rule 299.5705(5) if there is "a finding that the remedial action is protective of public health, safety, and welfare, and the environment." U.S. EPA has determined, and has made a finding that Alternative 2 - Monitored Natural Attenuation is protective of public health, safety, welfare and the environment (See discussions in Section 5, Current Site Conditions; Section 7, Risk Summary; and Section 11, The Selected Remedy). Therefore U.S. EPA has complied with the substantive requirements of Part 201 of Act 451 at Section 324.20118(5), and Rule 299.5705(5) is therefore waived.

Other Criteria, Advisories, or Guidance To Be Considered (TBCs) for This Remedial Action

In implementing remedies, U.S. EPA and the State will often consider a number of non-binding criteria. U.S. EPA refers to such non-binding criteria as criteria "to be considered" (TBCs). There were no TBCs at this site.

Cost-Effectiveness

In U.S. EPA's judgment, the selected remedy is "cost-effective" and represents a reasonable value for the money to be spent. In making this determination, U.S. EPA used the following definition: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." 40 C.F.R. § 300.430(f)(1)(ii)(D).

U.S. EPA evaluated cost-effectiveness here by first evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria - i.e., those alternatives that were protective of human health and the environment and complied with ARARs. U.S. EPA evaluated overall effectiveness by assessing three of the five balancing criteria in combination - long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; and short-term effectiveness. U.S. EPA then compared overall effectiveness to cost to determine cost-effectiveness. U.S. EPA determined that the selected remedy's overall effectiveness was proportional to its costs and that, therefore, the selected remedy represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected remedy is $145,000. U.S. EPA believes that the selected remedy's combination of stream capture, dilution and biodegradation will provide an overall level of protection comparable to Alternative 3, the groundwater pump and treat alternative, at a significantly lower cost.

Utilization of Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

U.S. EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, U.S. EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering: the statutory preference for treatment as a principal element; the statutory bias against off-site treatment and disposal; and State and community acceptance.

- *Long-term effectiveness*: the selected remedy reduces contamination of the groundwater and removes contamination from the groundwater.

- *Reducing toxicity, mobility and volume:* the selected remedy does not reduce the toxicity, mobility or volume of contamination. This is because this action does not address any source materials constituting principal threats at the site. U.S. EPA selected remedies satisfying the statutory preference for treatment in the June 23, 1992 ROD for OU 1 for drywell area soils and the more highly contaminated on-property groundwater.

- *Short-term effectiveness:* the selected remedy presents no short-term risks different from alternative remedies. Any risk due to the longer cleanup time will be minimal and managed.

- *Implementability:* the selected remedy is more implementable than alternative remedies of acceptable protectiveness -- specifically, alternative 3, groundwater pump and treat.

Preference for Treatment as a Principal Element

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. This is because OU2 consists of off-property groundwater contamination and does not contain any source materials that are a principal threat at the site. U.S. EPA selected remedies that satisfy the statutory preference for treatment in U.S. EPA's ROD for OU1 dated June 23, 1992. The OU1 remedies addressed source materials that are a principal threat at this site – the drywell area soils and more highly contaminated, on-property groundwater.

Five Year Review Requirements

This remedy will result in hazardous substances remaining in the off-property groundwater above levels that allow for unlimited use and unrestricted exposure. Therefore, U.S. EPA will conduct a review within five years after the initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Construction Completion Listing

U.S. EPA's selected remedy at this site does not require physical construction. Therefore, this site now qualifies for inclusion on the construction completion list.

13. EXPLANATION OF SIGNIFICANT CHANGES

Based on a comment received during the public comment period, U.S. EPA revised the description of the alternatives and the corresponding discussions in this ROD to provide corrected cleanup time frames for the monitored natural attenuation alternative and the groundwater pump and treat alternative. The cleanup time frames that U.S. EPA discussed in the proposed plan were based on modeling calculations conducted in the 1991 FS. The 1991 modeling indicated a cleanup time frame of 32 to 65 years for monitored natural attenuation and 15 to 30 years for groundwater pump and treat.

However, during the public comment period, a commenter correctly pointed out that in December 1991, U.S. EPA revised the groundwater modeling to address comments received during the 1991 public comment period. The revised modeling is discussed in the 1992 OU1 ROD on pages 33 to 36 of the Responsiveness Summary. This discussion shows U.S. EPA's corrected, recalculated cleanup time frames of 53 to 66 years for monitored natural attenuation and 35 to 42 years for groundwater pump and treat.

The recalculated lower end of the estimate for the cleanup time frame for monitored natural attenuation is 21 years longer than the lower end of the time frame U.S. EPA presented for this alternative in the proposed plan. However, the recalculated time frame is still within the original overall time frame of about 32 to 65 years U.S. EPA estimated for this alternative in the proposed plan. The recalculated time frames also indicate that the difference in the cleanup time frames between monitored natural attenuation and groundwater pump treat is actually less than indicated in the proposed plan. The recalculated time frames indicate a groundwater pump and treat alternative would cleanup the groundwater in about 2/3 of the time it would take for the groundwater to naturally attenuate. In its June 1999 proposed plan, U.S. EPA indicated that groundwater pump and treat would only take about ½ of the time it would take for the groundwater to naturally attenuate.

TABLES

TABLE 1

December 1998 Groundwater Monitoring Results - Electro-Voice Off-Property Groundwater. Chemical Concentrations in ug/l

Chemical	Monitoring Well Location													
	MW-2	MW-5	MW-8	MW-9D	MW-16	MW-17	MW-18S	MW-18D	MW-20	MW-21	MW-22	MW-23	MW-24	MW-25
Chlorobenzene									0.5					
1,1-Dichloroethane														0.5
cis-1,2-Dichloroethene						6.0	1.0				4.7	11	1.9	
Tetrachloroethene		2.0	2.3				2.0							
Trichloroethene			1.0	0.7	7.6	6.7	4.6	2.7	**15**	0.7	**23**	**20**	**6.2**	2.5
Vinyl chloride														
Benzene														
Ethylbenzene														
Xylene	0.8			0.5										

	MW-26S	MW-26D	MW-27S	MW-28	MW-30	MW-37	MW-38S
Chlorobenzene							
1,1-Dichloroethane			0.6			0.6	
cis-1,2-Dichloroethene	1.5	1.9		0.8	12.0		
Tetrachloroethene							
Trichloroethene	**21**	**26**	2.4	0.5	2.7	3.2	
Vinyl chloride					7.0		
Benzene							1.4
Ethylbenzene							5.6
Xylene							3.4

Non-Detect Wells MW-3, MW-7, MW-9S, MW-11, MW-13, MW-14, MW-19S, MW-19I, MW-19D, MW-27D, MW29, MW-33, MW-34, MW-35, MW-36, MW-38S, MW-38I, MW-38D.

TABLE 2
CHEMICALS OF CONCERN IN OFF-PROPERTY GROUNDWATER
December 1998

Chemical of Concern	Concentration Detected in Off-Property Groundwater (ppb)		Frequency of Detection	Background (for metals)	Frequency of Detection Above Background (for metals)	Concentrations Above Background	
	Min	Max					
TCE	0.5	26	16/30	-	-	-	
Vinyl Chloride	7	7	1/30	-	-	-	
Chromium (total)	0.65	11.6	28/30	1.2 - 3.8	3/30	11.6 4.7 6.2	MW-16 MW-17 MW-35
Copper	0.5	13.1	30/30	0.92 - 5.1	5/30	7.2 13.1 5.3 12.9 7.6	MW-17 MW-18D TW-19I MW-35 MW-38S
Zinc	6.8	7,240	30/30	8.7 - 2,890	2/30	5,290 7,240	MW-18D MW-35

TABLE 3
1991 RISK ASSESSMENT SUMMARY

Exposure Scenario	Reasonable Maximum Excess Lifetime Cancer Risk	Reasonable Maximum Non-Cancer Hazard	Unacceptable Cancer Risk?	Unacceptable Non-Cancer Risk?
Current Risks				
Workers in Front Street Businesses Exposed to Groundwater Vapors Infiltrating into Basements via Indoor Inhalation	8×10^{-7}	0.0006	No	No
Workers in Front Street Businesses Exposed to Groundwater Vapors Infiltrating into Basements via Indoor Inhalation if Vinyl Chloride Present in the Groundwater at 5 ppb (vinyl chloride not actually detected in this area)	5×10^{-4}	0.0006	Yes	No
Recreational Fisherman Using McCoy Creek Exposed to Contaminants via Ingestion and Dermal Exposure to Water and Fish Ingestion	3×10^{-8}	0.000004	No	No
Future Risks				
Residential Use of Groundwater for Drinking and Showering via Ingestion, Dermal Contact and Inhalation of Shower Vapors	4×10^{-4}	18.0	Yes	Yes

TABLE 4
EXPOSURE SCENARIOS AND EVALUATION CRITERIA USED IN UPDATED RISK EVALUATION

Exposure Scenario	**Federal and State Criteria Used to Evaluate Scenario**
Current	
Workers in Front Street Businesses Exposed to Groundwater Vapors Infiltrating into Basements via Indoor Inhalation	• Michigan Act 451 Part 201 generic residential groundwater volatilization to indoor air inhalation criteria
Recreational Fisherman Using McCoy Creek Exposed to Contaminants via Ingestion and Dermal Exposure to Water and Fish Ingestion	• Michigan Act 451 Part 31 groundwater surface water interface (GSI) criteria human non-drink values
Environmental Risk to McCoy Creek	Chemical concentrations in all monitoring wells near McCoy Creek compared to: • Background levels (for metals) • Michigan Act 451 Part 31 GSI criteria for the protection of McCoy Creek biota (GSI criteria and final chronic values)
Future	
Residential Use of Groundwater for Drinking and Showering via Ingestion, Dermal Contact and Inhalation of Shower Vapors	• Background levels (for metals) • Federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act • Michigan Act 451 Part 201 generic residential drinking water criteria
Environmental Risk to McCoy Creek	Chemical concentrations in all off-property monitoring wells compared to: • Background levels (for metals) • Michigan Act 451 Part 31 GSI criteria for the protection of McCoy Creek biota (GSI criteria and final chronic values)

TABLE 5
RISK EVALUATION

Chemical and Risk Evaluation Standards	Standard (ppb)	Chemical Detected Above Standard?	Number of Locations Above Standard or Above Background and Standard (for metals)	Concentrations and Locations Above Standard (ppb)	
Trichloroethene (TCE) **Concentrations: 0.5 - 26 ppb**					
MCL	5	Yes	8/30	7.6 6.7 15 23 20 6.2 21 26	MW-16 MW-17 MW-20 MW-22 MW-23 MW-24 MW-26S MW-26D
Michigan Part 201 Generic Residential Criteria	5	Yes	8/30	7.6 6.7 15 23 20 6.2 21 26	MW-16 MW-17 MW-20 MW-22 MW-23 MW-24 MW-26S MW-26D
Michigan Part 201 Volatilization Criteria	15,000	No	None	None	
Michigan Part 31 Generic GSI Criteria	200	No	None	None	
Michigan Part 31 Final Chronic Values	200	No	None	None	
Michigan Part 31 Human Non-Drink Values	370	No	None	None	

Chemical and Risk Evaluation Standards	Standard (ppb)	Chemical Detected Above Standard?	Number of Locations Above Standard or Above Background and Standard (for metals)	Concentrations and Locations Above Standard (ppb)	
Vinyl Chloride	**Concentration: 7 ppb**				
MCL	2	Yes	1/30	7	MW-30
Michigan Part 201 Generic Residential Criteria	2	Yes	1/30	7	MW-30
Michigan Part 201 Volatilization Criteria	110	No	None	None	
Michigan Part 31 Generic GSI Criteria	15	No	None	None	
Michigan Part 31 Final Chronic Values	-	-	-	-	
Michigan Part 31 Human Non-Drink Values	15	No	None	None	
Chromium (total)	**Concentrations Above Background: 4.7 - 11.6 ppb**				
MCL	100	No	None	None	
Michigan Part 201 Generic Residential Criteria	100	No	None	None	
Michigan Part 201 Volatilization Criteria	-	-	-	-	
Michigan Part 31 Generic GSI Criteria (Cr+6)	11	Yes	1	11.6	MW-16
Michigan Part 31 Final Chronic Values (C+3 - assumes 100 mg/L $CaCO_3$)	74	No	No	None	
Michigan Part 31 Human Non-Drink Values (Cr+3)	9,400	No	None	None	

Chemical and Risk Evaluation Standards	Standard (ppb)	Chemical Detected Above Standard?	Number of Locations Above Standard or Above Background and Standard (for metals)	Concentrations and Locations Above Standard (ppb)	
Copper Concentrations Above Background: 5.3 - 13.1 ppb					
MCL	1,300	No	None	None	
Michigan Part 201 Generic Residential Criteria	1,000	No	None	None	
Michigan Part 201 Volatilization Criteria	-	-	-	-	
Michigan Part 31 Generic GSI Criteria	-	-	-	-	
Michigan Part 31 Final Chronic Values (assumes 100 mg/L $CaCO_3$)	9	Yes	2/30	13.1 12.9	MW-18D MW-35
Michigan Part 31 Human Non-Drink Values	64,000	No	None	None	
Zinc Concentrations Above Background: 5,290 - 7,240					
MCL	-	-	-	-	
Michigan Part 201 Generic Residential Criteria	2,400	Yes	2	5,290 7,240	MW-18D MW-35
Michigan Part 201 Volatilization Criteria	-	-	-	-	
Michigan Part 31 Generic GSI Criteria	-	-	-	-	
Michigan Part 31 Final Chronic Values (assumes 100 mg/L $CaCO_3$)	118	Yes	2	5,290 7,240	MW-18D MW-35
Michigan Part 31 Human Non-Drink Values	22,000	No	None	None	

TABLE 6
RISK SUMMARY

Exposure Scenario	Does Scenario Pose a Risk?
Current	
Workers in Front Street Businesses Exposed to Groundwater Vapors Infiltrating into Basements via Indoor Inhalation	No
Recreational Fisherman Using McCoy Creek Exposed to Contaminants via Ingestion and Dermal Exposure to Water and Fish Ingestion	No
Environmental Risk to McCoy Creek	No
Future	
Residential Use of Groundwater for Drinking and Showering via Ingestion, Dermal Contact and Inhalation of Shower Vapors	Yes
Environmental Risk to McCoy Creek	Yes - If levels of chromium, copper and zinc detected above background levels in the area of off-property groundwater contamination near Electro-Voice move with the groundwater and empty into McCoy Creek at levels that would threaten the creek

TABLE 7
FEDERAL AND STATE ARARs

Federal ARARs

Resource Conservation and Recovery Act (RCRA)
Clean Air Act (CAA)
Clean Water Act (CWA)
Occupational Safety and Health Act (OSHA)
Safe Drinking Water Act (SWDA)

State ARARs

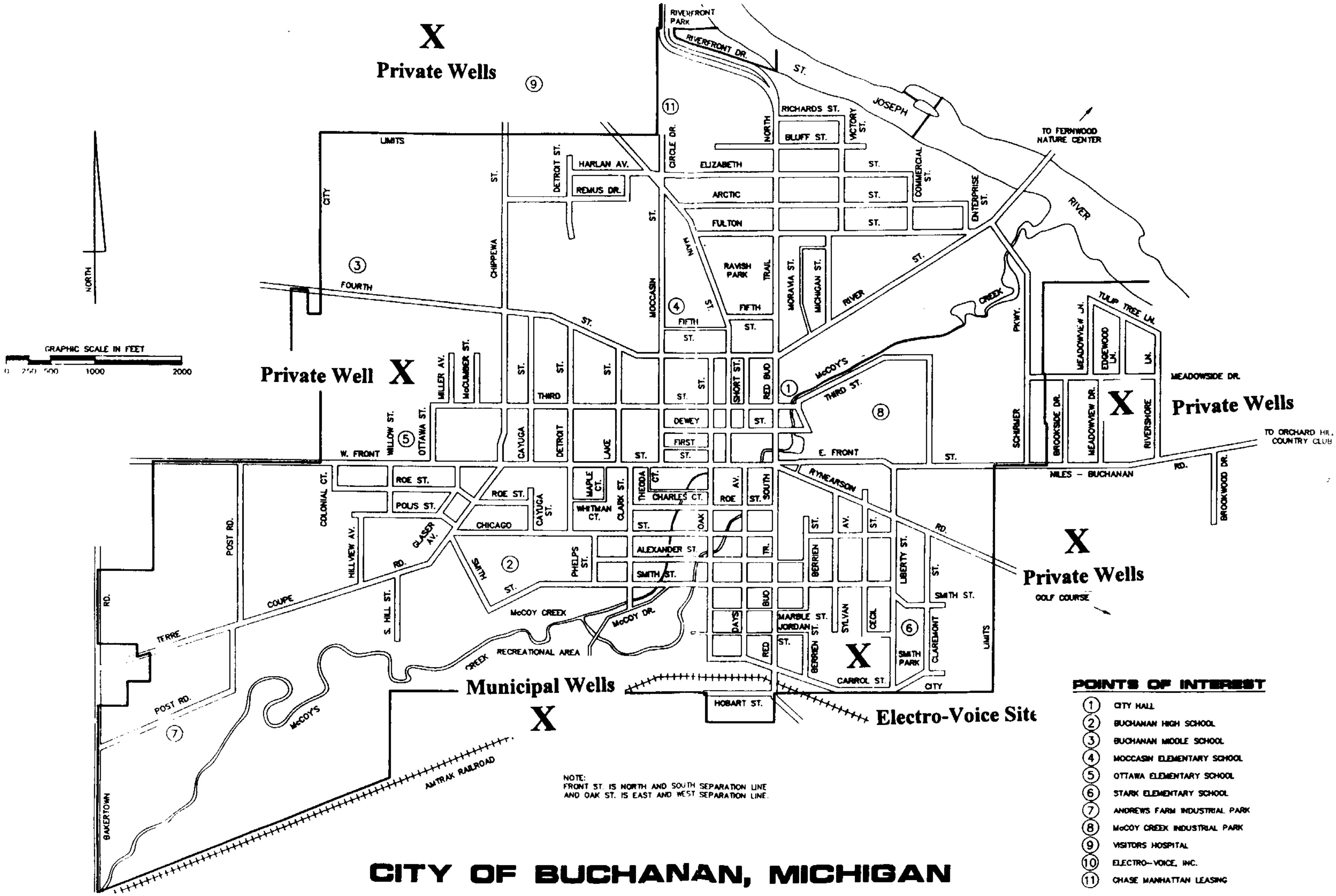
Michigan Natural Resources Environmental Protection Act (Act 451), including:

Hazardous Waste Management (Part 111)
Solid Waste Management (Part 115)
Liquid Industrial Waste (Part 121)
Water Resources Protection (Part 31)
Air Resources Protection (Part 55)
Mineral Wells (Part 625)
Soil Erosion and Sedimentation Control (Part 91)
Environmental Response (Part 201)

TABLE 8
CLEANUP STANDARDS FOR OFF-PROPERTY GROUNDWATER

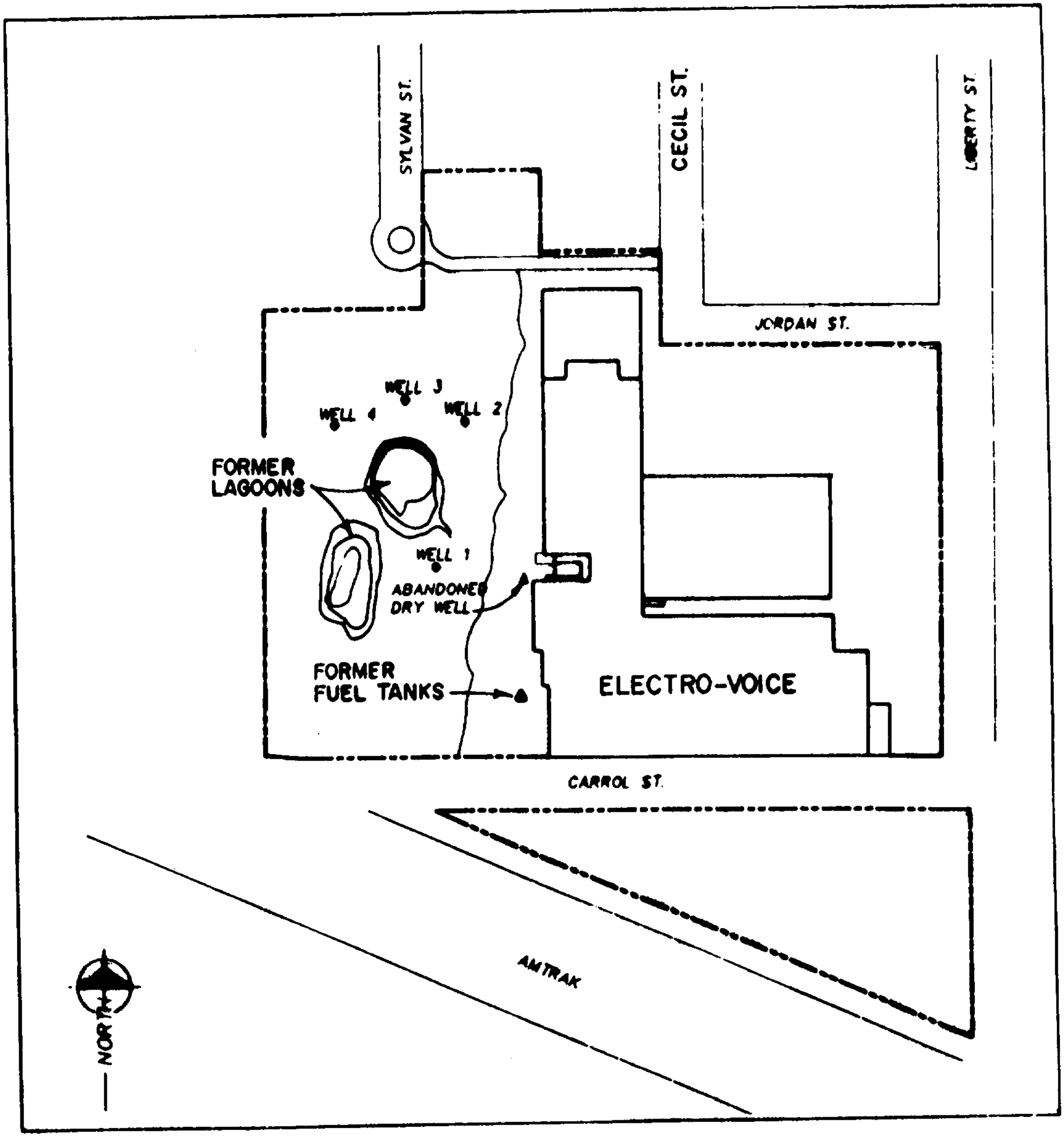
Chemical	Cleanup Standard (ppb)
Trichloroethene (TCE)	5
Vinyl Chloride	2

FIGURES



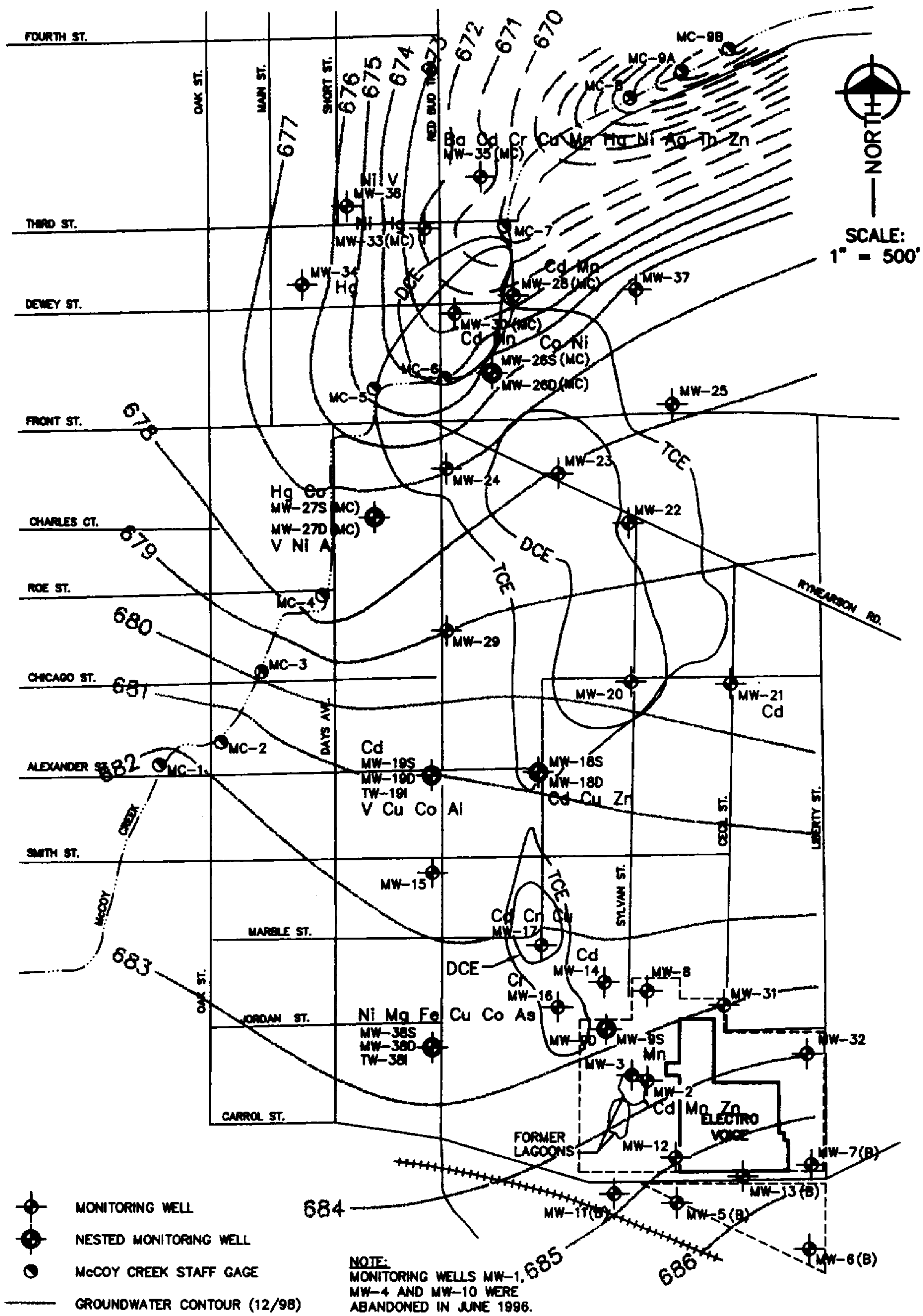
CITY OF BUCHANAN, MICHIGAN

FIGURE 1



SITE MAP

FIGURE 2



MONITORING WELL

NESTED MONITORING WELL

McCOY CREEK STAFF GAGE

GROUNDWATER CONTOUR (12/98)

TCE AND DCE PLUME LIMITS

(MC) DENOTES WELL NEAR McCOY CREEK

(B) DENOTES BACKGROUND WELL

NOTE:
MONITORING WELLS MW-1, MW-4 AND MW-10 WERE ABANDONED IN JUNE 1996.

METALS DETECTED ABOVE BACKGROUND

DECEMBER 1998

PLOT INFO: 93307S\CO\ZO2893307S.DWG DATE: 04/28/1999 TIME: 3:10 PM USER: DSM

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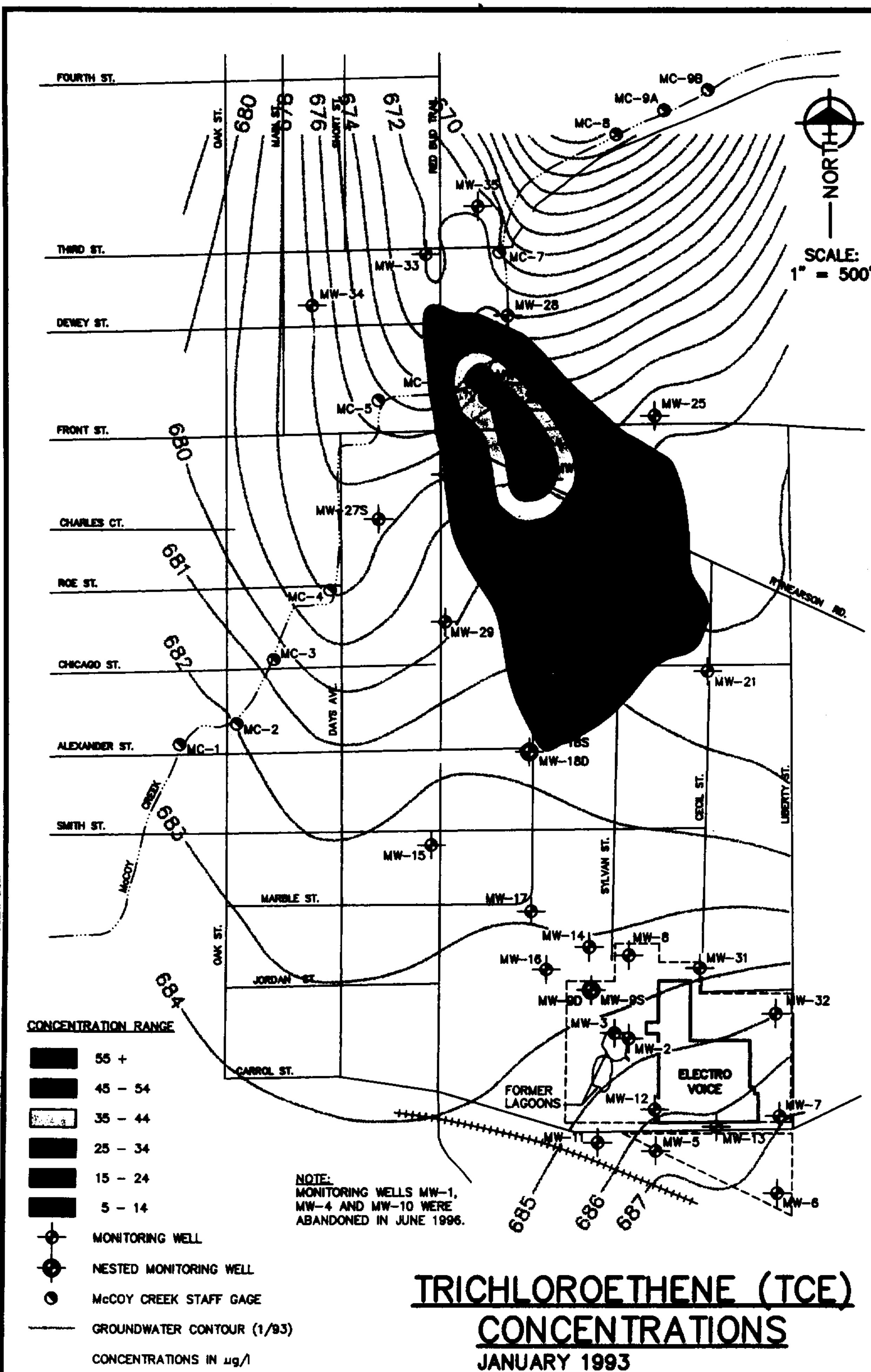
BUCHANAN, MICHIGAN

OFF-PROPERTY GROUNDWATER
TECHNICAL MEMORANDUM

PROJECT NO.
93307S

FIGURE NO.
3



TRICHLOROETHENE (TCE) CONCENTRATIONS

JANUARY 1993

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OFF-PROPERTY GROUNDWATER TECHNICAL MEMORANDUM

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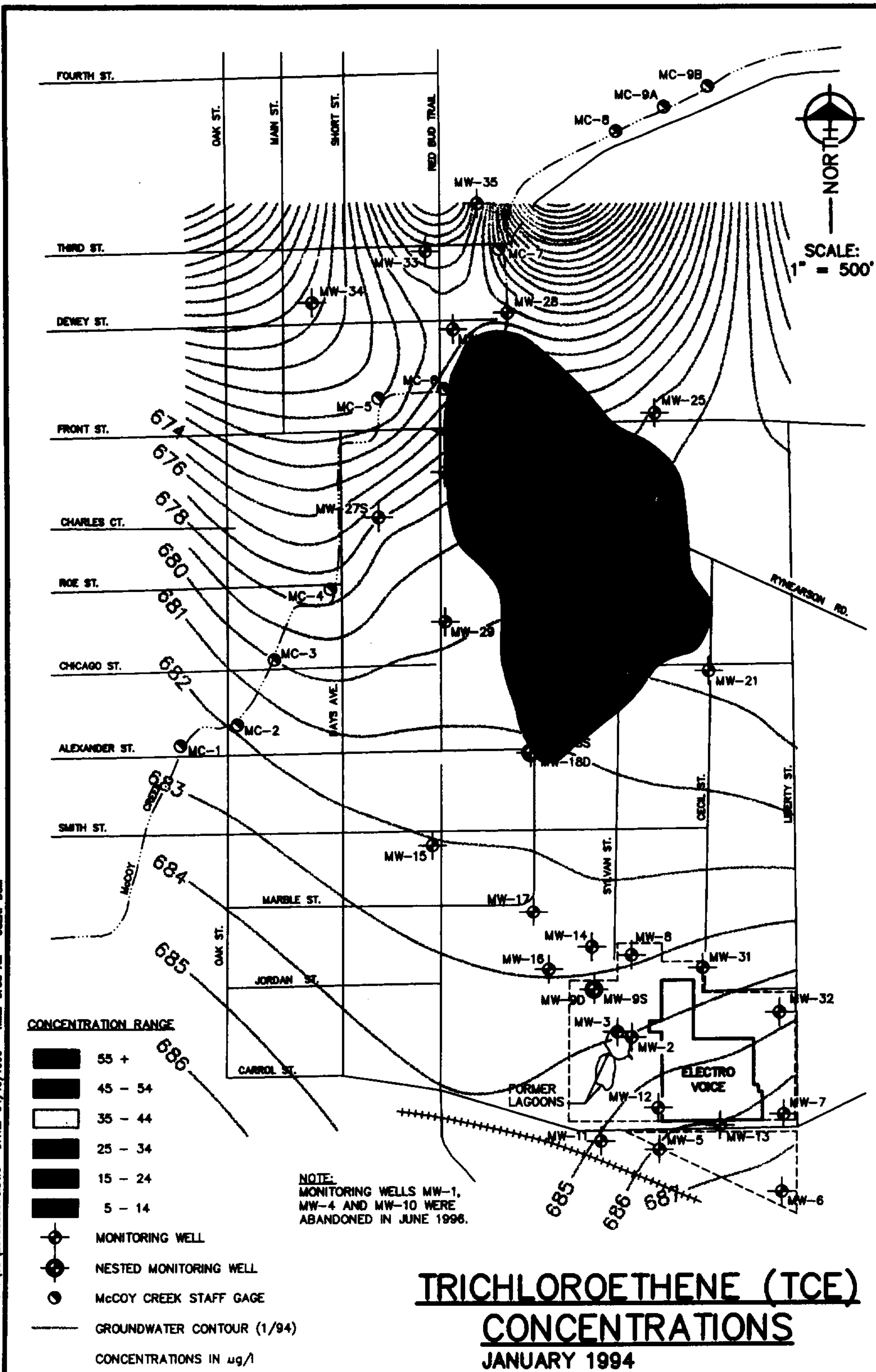
FIGURE NO. 4



TRICHLOROETHENE (TCE) CONCENTRATIONS

JANUARY 1994

PLOT INFO: 93307S\CD\2010933075.DWG DATE: 04/19/1999 TIME: 9:33 AM USER: DSM

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OFF-PROPERTY GROUNDWATER TECHNICAL MEMORANDUM

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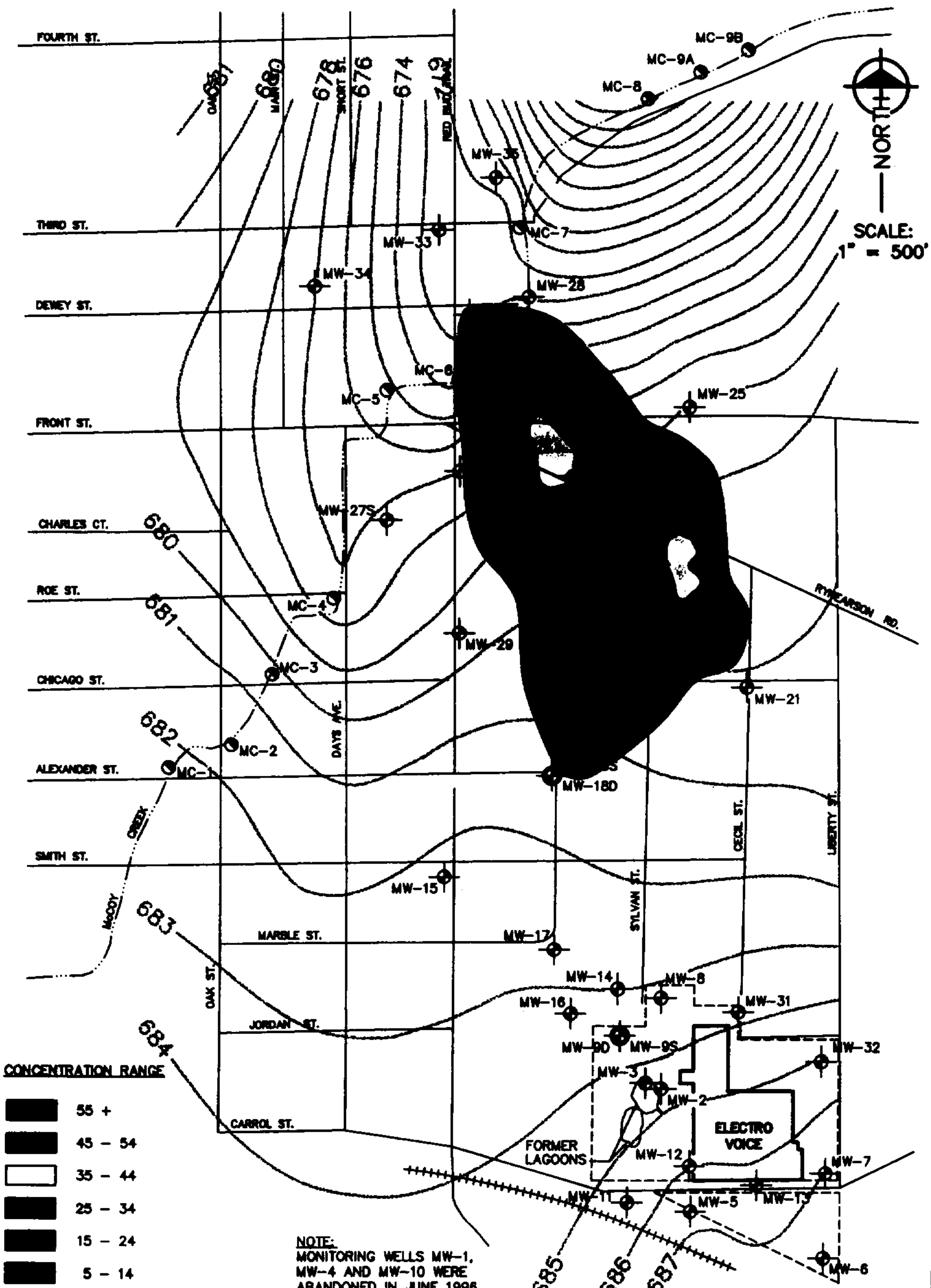
FIGURE NO. 5



NOTE:
MONITORING WELLS MW-1, MW-4 AND MW-10 WERE ABANDONED IN JUNE 1996.

CONCENTRATION RANGE

- 55 +
- 45 - 54
- 35 - 44
- 25 - 34
- 15 - 24
- 5 - 14
- MONITORING WELL
- NESTED MONITORING WELL
- McCOY CREEK STAFF GAGE
- GROUNDWATER CONTOUR (1/95)

CONCENTRATIONS IN µg/l

TRICHLOROETHENE (TCE) CONCENTRATIONS

JANUARY 1995

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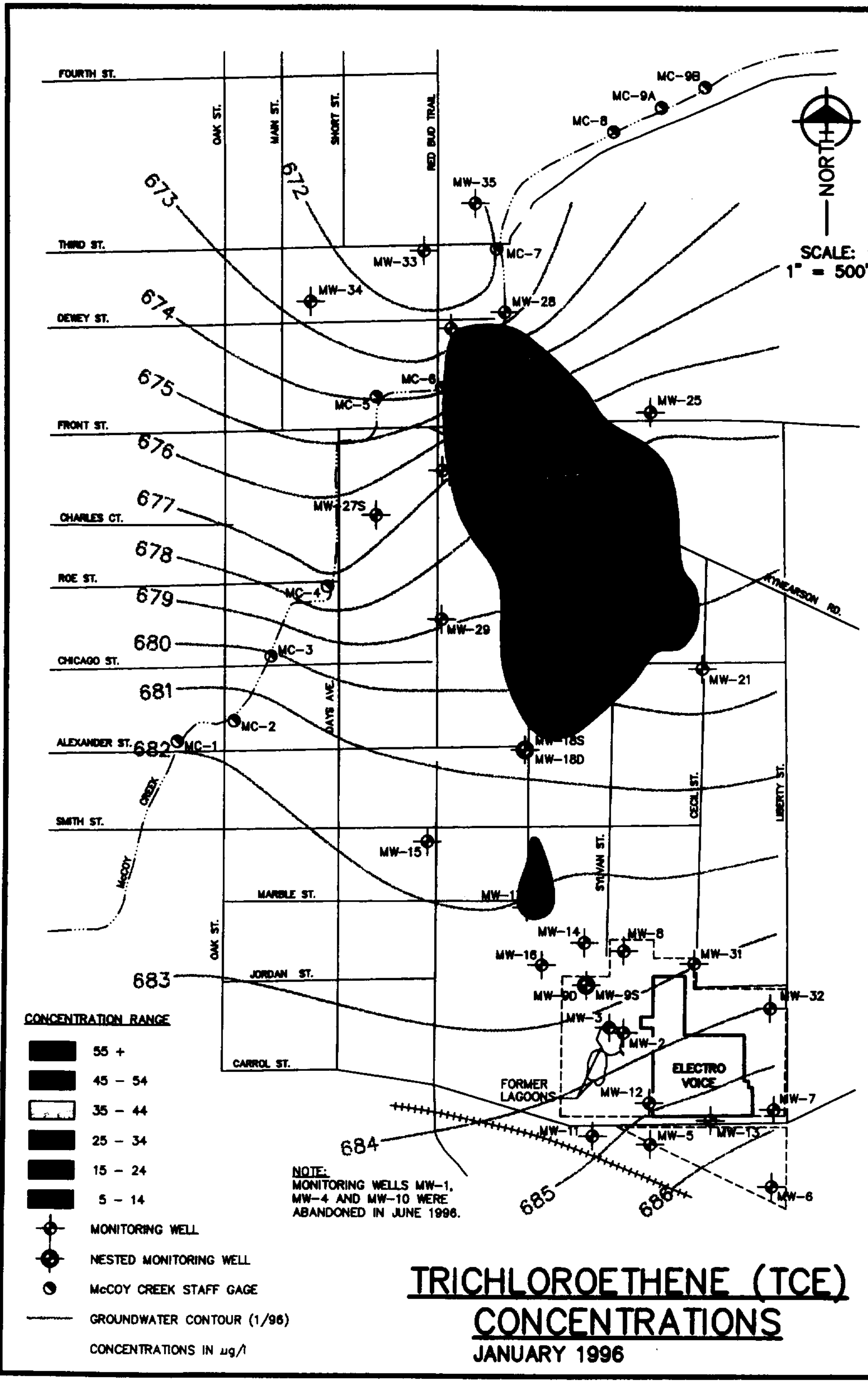
FIGURE NO. 6

PLOT INFO: 93307S\CD\Z01193307S.DWG DATE: 04/19/1999 TIME: 9:51 AM USER: DSM



TRICHLOROETHENE (TCE) CONCENTRATIONS

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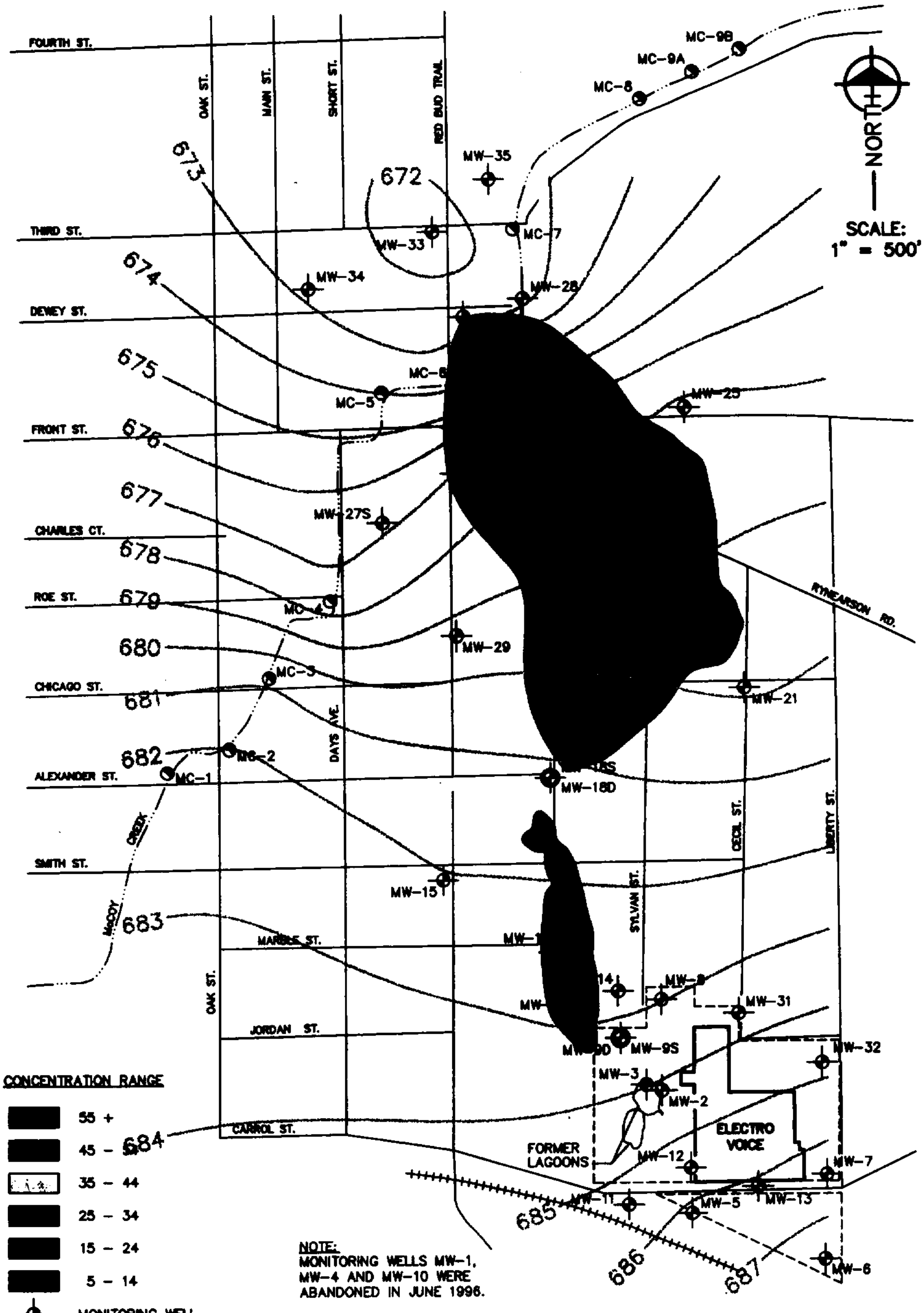
PROJECT NO. 93307S

FIGURE NO. 7

PLOT INFO: 93307S\(CD)\Z01293307S.DWG DATE: 04/19/1996 TIME: 1:34 PM USER: DSM



TRICHLOROETHENE (TCE) CONCENTRATIONS

DECEMBER 1996

PLOT INFO: 93307S\CD\Z01393307S.DWG DATE: 04/19/1999 TIME: 2:35 PM USER: DSM

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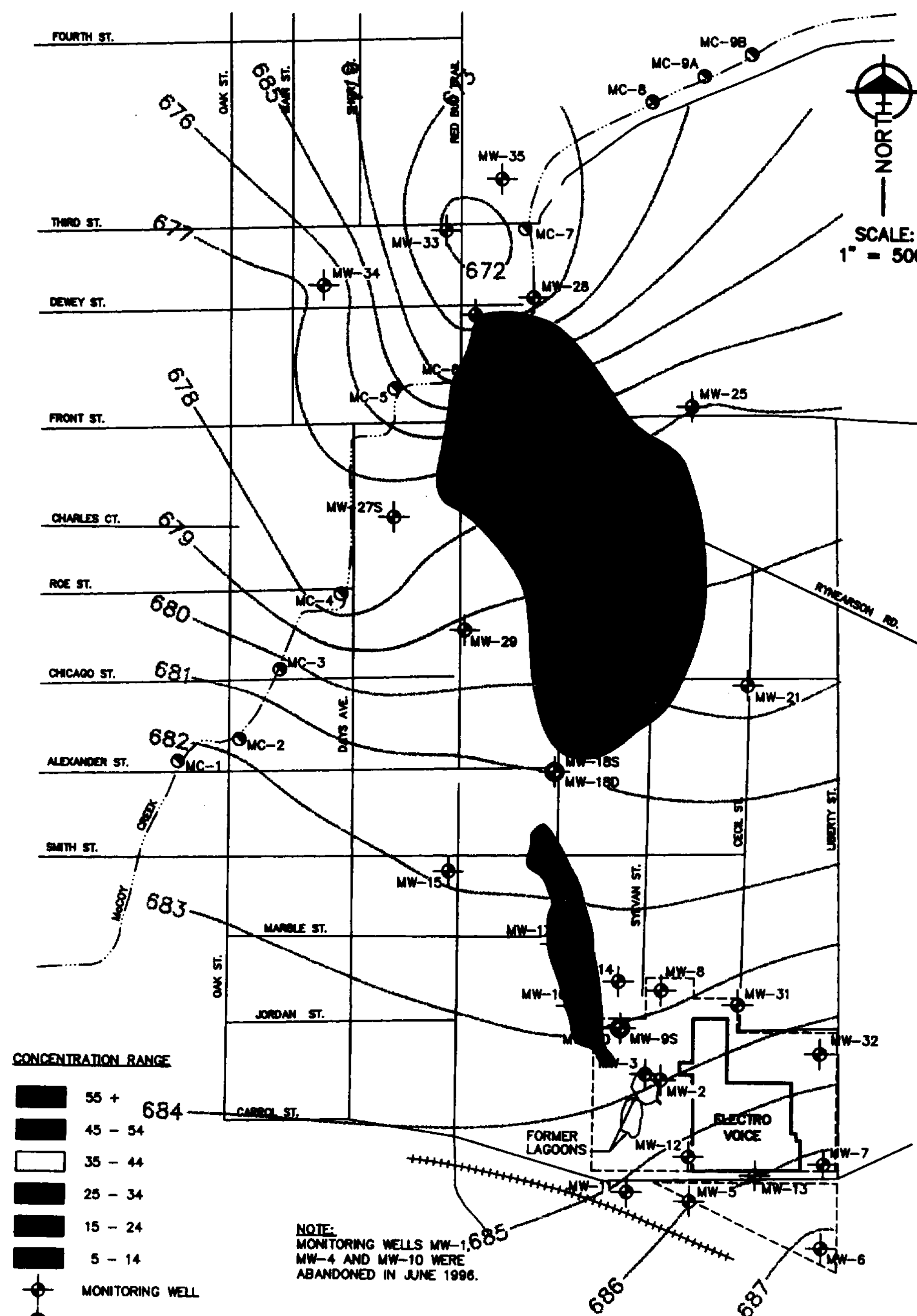
OFF-PROPERTY GROUNDWATER TECHNICAL MEMORANDUM

PROJECT NO. 93307S

FIGURE NO. 8



TRICHLOROETHENE (TCE) CONCENTRATIONS

DECEMBER 1997

PLOT INFO: 93307S\CD\Z014933073.DWG DATE: 04/19/1999 TIME: 10:57 AM USER: DSM

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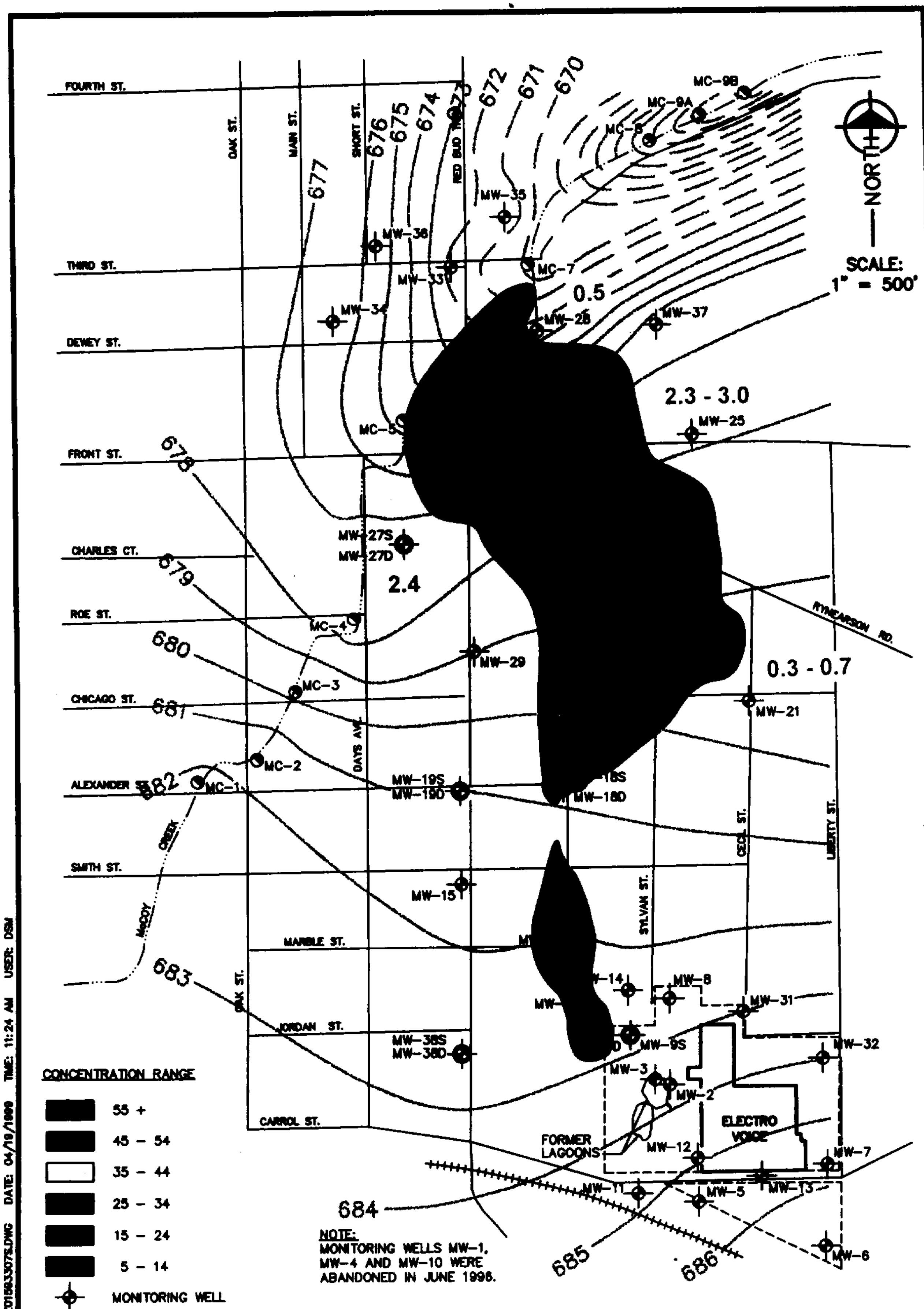
OFF-PROPERTY GROUNDWATER
TECHNICAL MEMORANDUM

PROJECT NO.
93307S

FIGURE NO.
9



TRICHLOROETHENE (TCE) CONCENTRATIONS

DECEMBER 1998

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PROJECT NO. 93307S

FIGURE NO. 10

PLOT INFO: 93307S\CD\Z01693307S.DWG DATE: 04/19/1999 TIME: 11:24 AM USER: DSM

ATTACHMENT 1

Detailed Analysis of Metals Results

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Aluminum												
Concentrations Above Background	4,110 - 6,520	4/10	2,880 - 3,300	70.7 - 88.8	2/11	-	0/3	ND - 69.9	384 1,200 271 321	MW-19I MW-27D MW-36 MW-37	4/36	13.9 - 227
Concentrations Below Background	1,100 - 3,220	6/10		26.3 - 45.3	4/11 ND = 5/11	17 - 54.5	3/3		7.2 - 173		27/36 ND = 5/36	

Comments: Aluminum was detected above background concentrations in 4/36 1998 wells. MW-19 is not in VOC plume. MW-36 is across McCoy Creek and not in VOC plume. MW-27 is 1,750 ft. downgradient of site and at western edge of VOC plume. MW-37 is 2,375 ft. downgradient of site and at eastern edge of VOC plume. Aluminum not detected above background in any of the other 32 wells including wells closer to the site and wells within the VOC plume. Aluminum was only detected slightly above background in 2 of 11 on- and near property wells during the RI. There is no GSI criteria for aluminum. The concentrations of aluminum in soil were also below state default background levels (6,900 mg/kg). There is no MCL for aluminum. The aesthetic MDEQ drinking water criteria for aluminum is 50 ug/L..

Antimony												
Concentrations Above Background	7.5 - 9.1	3/10	ND	-	0/11	27 27 27	3/3	ND	-	-	0/36	ND - 2.7
Concentrations Below Background	-	0/10 ND = 7/10		-	0/11 ND = 11/11	-	0/3	ND	2.2	MW-35	1/36 ND= 35/36	

Comments: Antimony was not detected above background in any 1998 groundwater samples. Antimony was detected below background levels in MW-35, which is across the creek and not in VOC plume. Antimony was not detected in any of the other 35 wells. Antimony was detected above background levels in three wells across the creek during the RI, but was not detected in any on- or near property wells during the RI. The three wells across the creek are not in the VOC plume. Antimony was detected above background concentrations in 3/10 soil samples during the RI. The concentration of antimony detected in soil was 7.9 to 9.1 mg/kg. Antimony was not detected in any of the other 7 soil samples collected during the RI. There is no GSI for antimony. The residential drinking water criteria for antimony is 6 ug/L.

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Arsenic												
Concentrations Above Background	6.8 - 14	5/10	2 - 4.7	-	0/11	-	0/3	ND - 13	42	MW-38S	1/36	3.4 - 9.0
Concentrations Below Background	2.9 - 4	5/10		1.9 - 5.6	3/11 ND = 8/11	3	3/3		1.7 - 8.3		30/36 ND = 5/36	
Comments: In 1998 arsenic was detected above background levels in MW-38S which is not within the VOC plume. Arsenic was either non-detect or detected below background levels in the other 35 wells. Arsenic was not detected above background concentrations in any on- or near property wells during the RI. Arsenic was detected below background concentrations in three wells across the creek and in three on- and near site wells during the RI. The three wells across the creek are not in the VOC plume. Arsenic was not detected in any of the other 8 on- and near property monitoring wells during the RI. Arsenic was detected above background levels in 5/10 soil samples during the RI. Soil concentrations ranged from 6.8 - 14 mg/kg. The GSI for arsenic is 150 ug/L and the residential drinking water standard is 50 ug/L.												
Barium												
Concentrations Above Background	15 - 89	6/10	12 - 13	-	0/11	-	0/3	46 - 297	239 442	MW-30 MW-35	2/36	51.2 - 211
Concentrations Below or within Background	4.8 - 10	4/10		43 - 115	11/11	44 - 162	3/3		40.8 - 155		34/36	
Comments: Barium was detected above background locations in 2/36 1998 wells. The highest concentration of barium, which is almost 2 times greater than the other concentration above background was in MW-35 which is across McCoy Creek and outside the VOC plume. Barium was detected slightly above background in MW-30, which is in the VOC plume but also across McCoy Creek. Barium was not detected above background concentrations in any of the other 34 wells, including wells closer to the site and wells within the plume. Barium was not detected above background concentrations in any on- or near property groundwater samples collected during the RI. Barium was detected above background in 6/10 soil samples collected during the RI, however only 1 of the samples above background (89 mg/kg) exceeded the state-wide default background of 75 mg/kg. The MCL for barium is 2,000 ug/L and the residential drinking water standard is 2,000 ug/L.												

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Beryllium												
Concentrations Above Background	0.46	1/10	0.39 - 0.4	-	0/11	-	0/3	ND - 9.4	-	-	0/36	ND
Concentrations Below or within Background	0.19 - 0.36	6/10 ND = 3/10		0.43 - 1.4	2/11 ND = 9/11	1	3/3		-		0/36 ND = 36/36	
Comments: Beryllium was not detected in any 1998 monitoring wells. Beryllium was detected below background in three wells across the creek during the RI and in 2 on- and near site wells during the RI. Beryllium was not detected in any of the other 9 on- or near site wells during the RI. Beryllium was detected above background soil concentrations in one soil sample during the RI. Beryllium was either non-detect or below background concentrations in the other 9 soil samples. The Final Chronic Value GSI for beryllium is 2.4 (assuming a default hardness of 100 mg/l CaCO3) and the Non-Drink Surface Water GSI is 1,200 ug/L. The residential drinking water criteria for beryllium is 4 ug/L.												
Cadmium												
Concentrations Above Background	0.85 - 735	8/10	ND	-	0/11	--	0/3	ND - 12.4	0.35 17.6	MW-18D MW-35	2/36	ND - 0.25
Concentrations Below or within Background	-	0/10 ND = 2/10		-	0/11	5	3/3		0.11 - 0.20		7/36 ND=27/36	
Comments: Cadmium was detected above background in 2/36 1998 wells. The highest concentration of cadmium (17.6 ug/L) was in MW-35 which is across McCoy Creek and outside the VOC plume. Cadmium was detected slightly above background (0.35 ug/L vs. 0.25 ug/L) in MW-18D, which is approximately 875 ft. downgradient of the site and within the VOC plume. Cadmium was detected below background in 7/36 wells and was non-detect in the remaining 27/36 wells. Cadmium was detected below background concentrations in three wells across McCoy Creek during the RI, but was not detected in any on- or near site wells during the RI. Cadmium was detected significantly above background concentrations in 8/10 soil samples during the RI and was non-detect in the remaining 2 samples. The Final Chronic Value GSI for cadmium is 2.2 (assuming a default hardness of 100 mg/l CaCO3) and the Non-Drink Surface Water GSI is 130 ug/L. The residential drinking water criteria for cadmium is 5 ug/L.												

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Chromium												
Concentrations Above Background	8.9 - 1340	7/10	5.5 - 8.4	18.8	1/11	-	0/3	ND - 8.9	11.6 4.7 6.2	MW-16 MW-17 MW-35	3/36	1.2 - 3.8
Concentrations Below or within Background	3.5 - 7.5	3/10		8.4	1/11 ND = 9/11	6	3/3		0.65 - 3.8		28/36 ND = 5/36	
Comments: Chromium was detected above background in 3/36 1998 wells. One of the wells, MW-35, is across McCoy Creek and not in the VOC plume. Chromium was detected slightly above the GSI for chromium +6 in MW-16 (11.6 ug/L vs. 11 ug/L) and below the criteria in MW-17. MW-16 is 50 ft. downgradient of the site and MW-17 is 300 ft. downgradient of the site. Both wells are in the VOC plume. Chromium was either non-detect or detected below background in the other 33 wells. Chromium was detected above background groundwater concentrations in MW-17 during the RI and below background concentrations in MW-16 during the RI. Chromium was not detected in any other on- or near site wells during the RI, but was detected below background in three wells on the other side of McCoy Creek. Chromium was detected above background soil concentrations in 7/10 soil samples collected during the RI and below background concentrations in the remaining 3 soil samples. All analyses have been for total chromium. The GSI for chromium +6 is 11 ug/L and the residential drinking water standard for total chromium is 100 ug/L. The Final Chronic Value GSI for chromium +3 is 74 ug/L (assuming a default hardness of 100 mg/l CaCO3) and the Surface Water Non-Drink Value for chromium +3 is 9,400 ug/L.												
Cobalt												
Concentrations Above Background	-	0/10	2.1 - 6.1	-	0/11	-	0/3	ND - 24.9	1.2 1.3 1.7 12.1	MW-19I MW-26S MW-27D MW-38S	4/36	ND - 0.72
Concentrations Below or within Background	2.3 - 5.3	10/10		2.6 - 16.6	8/11 ND = 3/11	3	3/3		0.51 - 0.60		3/36 ND= 29/36	
Comments: Cobalt was detected above background in 4/36 1998 wells. The highest concentration of cobalt (12.1 ug/L) was in MW-38S which is 500 ft. west of site and not in VOC plume. MW-19 is 1,000 ft. from the site and also not in the VOC plume. MW-27S is 1,750 ft. downgradient of the site and at the western boundary of VOC plume. MW-26 is 2,250 ft. downgradient of site and is in the VOC plume. Cobalt was detected below background concentrations in 3/36 wells and was not detected in the remaining 29/36 wells, including wells closer to the site and wells within the plume. Cobalt was not detected above background concentrations in on or near site wells during the RI. Cobalt was also not detected above background concentrations in soil during the RI. Soil concentrations of cobalt ranged from 2.3 mg/kg to 5.3 mg/kg. These concentrations are below the state-wide default background level of 6.8 mg/kg. The GSI for cobalt is 100 ug/L and the MDEQ residential drinking water criteria is 50 ug/L. There is no MCL for cobalt.												

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Copper												
Concentrations Above Background	27 - 152	7/10	10 - 15	-	0/11	-	0/3	ND - 26	7.2 13.1 5.3 12.9 7.6	MW-17 MW-18D TW-19I MW-35 MW-38S	5/36	0.92 - 5.1
Concentrations Below or within Background	8 - 15	3/10		13 - 26	6/11 ND = 5/11	7 - 15.4	3/3	ND - 26	0.50 - 4.2		31/36 ND=0/36	

Comments: Copper was detected above background concentrations in 5/36 1998 wells. Three of the wells (TW-19I, MW-35 and MW-38) are outside the VOC plume. The other 2 wells, MW-17 and MW-18, are in the VOC plume and are 300 and 875 ft. downgradient of the site. Copper was not detected above background levels in any on- or near site wells during the RI. Copper was detected above background soil concentrations in 7/10 soil samples during the RI and below background levels in 3/10 samples. The Final Chronic Value GSI for copper is 9 ug/L (assuming a default hardness of 100 mg/l $CaCO_3$) and the Surface Water Non-Drink Value for copper is 64,000 ug/L. The MDEQ aesthetic drinking water criteria for copper is 1,000 ug/L and the MCL is 1,300 ug/L.

Iron												
Concentrations Above Background	15, 600	1/10	6,230 - 12,700	-	0/18	-	0/3	ND - 25, 600	32,600	MW-38S	1/36	59.8 - 17,800
Concentrations Below or within Background	4,470 - 12,000	9/10		4 - 14, 300	18/18 (includes additional wells between site and McCoy Creek)	4 - 30.2	3/3	ND - 25, 600	37.1 - 14,600		35/36 ND= 0/36	

Comments: Iron was detected above background concentrations in 1/36 1998 wells (MW-38S). MW-38 is not in the VOC plume. Iron was not detected above background concentrations in any of the other 35/36 wells, including wells closer to the site and wells within the VOC plume. Iron was not detected above background concentrations in any on- or near site wells, or downgradient wells during the RI. Iron was detected above background soil concentrations in 1/10 soil samples collected during the RI. The remaining 9/10 soil samples were below background levels. There is no GSI or MCL for iron. The MDEQ aesthetic drinking water value for iron is 300 ug/L.

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Lead												
Concentrations Above Background	17 - 83	6/10	5.4 - 15	2.9 - 3.4	1/11	-	0/3	ND - 2.6	-	-	0/36	0.82 - 21.7
Concentrations Below Background	4.6 - 9.6	4/10		1.4	1/11 ND = 9/11	2	3/3		0.67 - 21.5		33/36 ND = 3/36	
Comments: Lead was not detected in any 1998 groundwater samples above background levels. Lead was detected only slightly above background in 1 of 11 on-site groundwater samples during the RI. Lead was detected above background in 6/10 soil samples collected during the RI, however only 2 of these samples (31 mg/kg and 83 mg/kg) exceeded the state default background level of 21 mg/kg. The Final Chronic Value GSI for lead is 12 (assuming a default hardness of 100 mg/l CaCO3). The Surface Water Non-Drink GSI is 190 ug/L.												
Manganese												
Concentrations Above Background	-	0/10	196 - 721	546 - 673	2/11	-	0/3	4.2 - 502	1,150 1,330 825 996 3,280	MW-02 MW-9S MW-28 MW-30 MW-35	5/36	0.46 - 504
Concentrations Below Background	225 - 707	10/10		1.8 - 447	9/11	21.8 - 446	3/3		0.99 - 369		23/36 ND = 2/36	
Comments: Manganese detected above background levels in 5/36 wells. 2 wells (MW-2 and MW-9) are on-site; 1 well (MW-28) is 2,500 ft. downgradient of the site at northeast edge of plume; and 1 well (MW-30) is in the VOC plume across the creek. MW-35, with manganese concentrations 2 1/2 times the other concentrations above background, is on the other side of McCoy Creek and is not in the VOC plume. Manganese concentrations within the plume range from 1 ug/L to 369 ug/L and do not show any clear decreasing trend away from site. Manganese was not detected above background concentrations in any of the other 31 wells, including wells closer to the site and wells within the VOC plume. Manganese was only detected above background groundwater concentrations in 2 of 11 wells during the RI. Manganese was not detected above background soil concentrations. No cleanup standards were established for manganese in on-site groundwater in the 1991 ROD. There is no GSI for manganese. There is no MCL for manganese. The MDEQ aesthetic drinking water value for manganese is 50 ug/L.												

Detailed Analysis of Metals Results and Comparison to Criteria

Chemical	Soil - RI: Lagoons and Drywell Area (mg/kg)	Soil - RI: Frequency of Detection	Soil - RI: Background Concentrations - 2 samples (mg/kg)	Groundwater - RI: On- and Near-Property (ug/L)	Groundwater - RI: Frequency of Detection Above/Below Background	Groundwater - RI: Across Creek MW-33 MW-34 MW-35 (ug/L)	Groundwater - RI: Frequency of Detection Above/Below Background	Groundwater - RI: Background Concentrations (ug/L)	Groundwater - 1998: All Monitoring Wells (ug/L)		Groundwater - 1998: Frequency of Detection Above/ Below Background	Groundwater - 1998: Range of Background Concentrations (ug/L)
Mercury												
Concentrations Above Background	0.69	1/10	ND	-	0/11	0.2	3/3	ND	0.13 0.32 0.14 0.16	MW-27S MW-33 MW-34 MW-35	4/36	ND
Concentrations Below Background	-	0/10 ND = 9/10		-	0/11 ND = 11/11	-	0/3		-		0/36 ND=32/36	

Comments: Mercury was detected in 4 wells. Three of the wells are across McCoy Creek and not in the VOC plume. The fourth well, MW-27, is 1,875 ft. downgradient of site and at the western edge of the VOC plume. Mercury was not detected in any of the other 32 wells including wells closer to the site and wells within the VOC plume. Mercury was detected in 3 wells across McCoy Creek during the RI. These wells are not in the VOC plume. Mercury was not detected in any on- or near site wells during the RI. Mercury was detected above background soil concentrations in 1 of 10 soil samples during the RI (DW 28.5-31), but was not detected in the duplicate sample from this location. The GSI for mercury is 0.2 ug/L and the residential drinking water criteria is 2 ug/L.

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Nickel												
Concentrations Above Background	25 - 133	7/10	8.1 - 17	52.3	1/11	38	3/3	ND	3.4 3.9 3.6 3.3 5.9 6.4 4.3 24.9 7.6 3.9 16.5	MW-19D MW-19I MW-21 MW-24 MW-26S MW-27D MW-33 MW-35 MW-36 MW-37 MW-38S	11/36	ND - 3.2
Concentrations Below Background	7.1 - 16	3/10		-	0/11 ND = 10/11	-	0/3		1.1 - 2.9		17/36 ND= 8/36	

Comments: Nickel was detected above background levels in 11/36 wells. The highest concentration of nickel was in MW-35 which is across the creek and not in the VOC plume. Five other wells are also not in the VOC plume (MW-19I, MW-19D, MW-33, MW-36 and MW-38). MW-33 and MW-36 are also across the creek. Three wells (MW-21, MW-27 and MW-37) are 1,175 to 2,375 ft. downgradient of the site and are at the very eastern and western boundaries of the plume. Two wells MW-24 and MW-26 are within the plume, however, these wells are 2,000 to 2,250 ft. downgradient of the site. Nickel was either not detected or not detected above background in any of the other 25 wells, including other wells closer to the site and wells within the plume. Nickel was detected in one near property well and in three wells across the creek during the RI. The three wells across the creek are not in the VOC plume. Nickel was not detected in any other on- or near property well during the RI. The Final Chronic Value GSI for nickel is 52 ug/L (assuming a default hardness of 100 mg/l $CaCO_3$). The Surface Water Non-Drink GSI is 210,000 ug/L.

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Selenium												
Concentrations Above Background	-	-	ND	-	0/11	2 -10	3/3	ND	3.6 3.3 3.7 3.4 3.6 3.8 3.1	MW-19D MW-19S MW-22 MW-25 MW-26D MW-26S MW-27D	7/36	ND - 3.0
Concentrations Below Background	-	0/10 ND = 10/10		-	0/11 ND = 11/11	-	0/3		1.6 - 2.9		18/36 ND = 11/36	
Comments: Selenium was detected slightly above background levels (3.1 - 3.8 ug/L vs 3.0 background) in 7/36 wells. Two wells (MW-19D and MW-19S) are outside the VOC plume. Two wells (MW-25 and MW-27) are 1,750 to 1,875 ft. downgradient of the site and are at the eastern and western edges of the VOC plume. Three wells (MW-22, MW-26D and MW-26S) are within the plume, however, these wells are 1,750 to 2,250 ft. downgradient of the site. Selenium was either not detected or not detected above background in any of the other 29 wells, including other wells within the plume and closer to the site. Selenium was detected above background in 3 wells across McCoy Creek during the RI. These wells are not in the VOC plume. Selenium was not detected in any on- or near site wells during the RI. Selenium was also not detected in any soil samples during the RI. The GSI for selenium is 5 ug/L and the residential drinking water criteria is 50 ug/L.												
Silver												
Concentrations Above Background	77	1/10	ND	-	0/10	3	3/3	ND	0.16	MW-35	1/36	ND
Concentrations Below Background	-	0/10 ND = 9/10		-	0/10 ND = 10/10	-	0/3		-		0/36 ND = 35/36	
Comments: Silver was only detected in 1/36 wells. The detection of silver was in MW-35, which is located across McCoy Creek and is not in the VOC plume. Silver was not detected in any other wells, including wells closer to the site and wells within the plume. Silver was detected in three wells across the creek during the RI, but was not detected in any on- or near site wells during the RI. The three wells across the creek are not in the VOC plume. Silver was detected in 1/10 soil samples during the RI. Silver was not detected in any other soil samples collected during the RI and was not detected in background soil. The GSI for silver is 0.2 ug/L and the residential drinking water criteria is 34 ug/L.												

Detailed Analysis of Metals Results and Comparison to Criteria

<table>
<tr><th></th><th colspan="3">Soil - RI</th><th colspan="5">Groundwater - RI</th><th colspan="4">Groundwater - 1998</th></tr>
<tr><th>Chemical</th><th>Lagoons and Drywell Area (mg/kg)</th><th>Frequency of Detection</th><th>Background Concentrations - 2 samples (mg/kg)</th><th>On- and Near-Property (ug/L)</th><th>Frequency of Detection Above/Below Background</th><th>Across Creek MW-33 MW-34 MW-35 (ug/L)</th><th>Frequency of Detection Above/Below Background</th><th>Background Concentrations (ug/L)</th><th colspan="2">All Monitoring Wells (ug/L)</th><th>Frequency of Detection Above/ Below Background</th><th>Range of Background Concentrations (ug/L)</th></tr>
<tr><td colspan="13">Thallium</td></tr>
<tr><td>Concentrations Above Background</td><td>0.4 - 0.42</td><td>2/10</td><td>ND</td><td>-</td><td>0/10</td><td>2</td><td>3/3</td><td>ND</td><td>-</td><td>-</td><td>0/36</td><td>ND</td></tr>
<tr><td>Concentrations Below Background</td><td>-</td><td>8/10
ND = 8/10</td><td></td><td>-</td><td>0/10
ND = 10/10</td><td>-</td><td>0/3</td><td></td><td colspan="2">-</td><td>0/36
ND =
36/36</td><td></td></tr>
<tr><td colspan="13">Comments: Thallium was not detected in any wells. However, in one well (MW-35) the detection limit for thallium was 10 ug/L, which is above the GSI criteria of 3.7 ug/L. Thallium was detected in three wells across the creek during the RI, but was not detected in any on- or near site wells during the RI. The three wells across the creek are not in the VOC plume. Thallium was detected at low levels (0.4 to 0.42 mg/kg) in 2/10 soil samples during the RI. Thallium was not detected in any other soil samples during the RI. The residential drinking water criteria is 2 ug/L.</td></tr>
<tr><td colspan="13">Vanadium</td></tr>
<tr><td>Concentrations Above Background</td><td>11 - 16</td><td>4/10</td><td>8.4 - 10</td><td>-</td><td>0/11</td><td>-</td><td>0/3</td><td>2 - 17</td><td>1.6
1.6
0.84</td><td>MW-19I
MW-27D
MW-36D</td><td>3/36</td><td>ND</td></tr>
<tr><td>Concentrations Below Background</td><td>5 - 9.9</td><td>6/10</td><td></td><td>4.1 - 17</td><td>11/11</td><td>2</td><td>3/3</td><td></td><td colspan="2">-</td><td>0/36
ND = 3/36</td><td></td></tr>
<tr><td colspan="13">Comments: Vanadium was detected in 3/36 wells above background. MW-36 is across the creek and not in the VOC plume. MW-19I is not in the VOC plume. MW-27 is 1,875 ft. downgradient and at the western edge of the VOC plume. Vanadium was not detected above background in any on- or near property wells during the RI. Vanadium was detected slightly above background concentrations in 4/10 soil samples during the RI (11 - 16 mg/kg vs. 8.4 - 10 mg/kg background). The GSI for vanadium is 12 ug/L and the residential drinking water criteria is 64.</td></tr>
</table>

Detailed Analysis of Metals Results and Comparison to Criteria

	Soil - RI			Groundwater - RI					Groundwater - 1998			
Chemical	Lagoons and Drywell Area (mg/kg)	Frequency of Detection	Background Concentrations - 2 samples (mg/kg)	On- and Near-Property (ug/L)	Frequency of Detection Above/Below Background	Across Creek MW-33 MW-34 MW-35 (ug/L)	Frequency of Detection Above/Below Background	Background Concentrations (ug/L)	All Monitoring Wells (ug/L)		Frequency of Detection Above/ Below Background	Range of Background Concentrations (ug/L)
Zinc												
Concentrations Above Background	83 - 999	5/10	40 - 77	1,080 - 1,200	2/11	-	0/3	69 - 1,080	5,290 7,240	MW-18D MW-35	2/36	8.7 - 2,890
Concentrations Below Background	31 - 63	5/10		15.5 - 896	9/11	171 - 575	3/3		6.8 - 2,780		34/36	
Comments: Zinc was detected above background concentrations in 2/36 wells. The highest concentration of zinc (7,240 ug/L) was in MW-35 which is across the creek and not in the VOC plume. The other detection of zinc above background levels was in MW-18, which is in the VOC plume. Zinc was not detected above background levels in any of the other 34 wells including wells closer to the site and wells within the plume. Zinc was detected above background levels in 2/11 on- and near site wells during the RI. The Final Chronic Value GSI for zinc is 118 ug/L (assuming a default hardness of 100 mg/l CaCO3). The Surface Water Non-Drinking Water GSI for zinc is 22,000 ug/L. The residential drinking water criteria is 2,400 ug/L.												
Cyanide												
Concentrations Above Background	7.5 - 24	5/10	ND	390 - 2,070	2/11	-	0/3	ND - 176	-	-	0/36	ND
Concentrations Below Background	-	0/10 ND = 5/10		-	0/11 ND = 9/11	-	0/3 ND = 3/3		-		0/36 ND = 36/36	
Comments: Cyanide was not detected in any of the 1998 wells. Cyanide was detected above background concentrations in 2 on- and near property wells during the RI, but was non-detect in the remaining 9/11 wells. Cyanide was detected above background concentrations in 5/10 soil samples collected during the RI. Cyanide was non-detect in the remaining 5/10 samples. The GSI for cyanide is 20 ug/L and the residential drinking water criteria is 200 ug/L.												

ATTACHMENT 2

Buchanan Ordinance, Draft Revised Ordinance and Updated Restricted Area, and Example Deed Restriction

AN ORDINANCE AMENDING CHAPTER 38 OF THE CODE OF ORDINANCES TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH BY PROHIBITING THE USE OF CONTAMINATED GROUNDWATER; AND PROVIDING A PENALTY FOR THE VIOLATION THEREOF.

THE CITY OF BUCHANAN ORDAINS:

Section 1. Addition of Article IV to Chapter 38.

Article IV is added to Chapter 38 (Environment) of the Cod. of Ordinances, City of Buchanan, Michigan as follows:

Article IV. Groundwater Protection

Sec. 38-90 Purpose and Policy.

This article imposes institutional controls to protect the health of the residents of the City from any adverse impact that they may experience from groundwater that has been designated as contaminated by a state or federal regulatory agency.

Sec. 38-91 Prohibition on Groundwater Removal.

No person shall install a water well on, use any existing well on, or pump or otherwise use any groundwater which has been designated as contaminated by a state or federal regulatory agency or any groundwater from beneath the surface of any property located in the City which has been designated as contaminated by a state or federal regulatory agency unless such activity has been approved by the appropriate state or federal regulatory agency as part of a remediation plan.

Sec. 38-92 Penalty.

Any person who is found guilty by a court of competent jurisdiction of violating any provision of this article shall be punished as provided in section 1-15 of this Code. Each day any violation of this article shall continue shall constitute a separate offense. Upon application to any court of competent jurisdiction, the court may order the violation restrained and enjoined. The cessation of the activity that violates this article shall not preclude enforcement of this article by complaint for violation of this article and the imposition of fine or imprisonment as provided in section 1-15 of this Code.

Sec. 38-93 Notice to Change to State of Michigan.

The City shall give to the Michigan Department of Environmental Quality or its successor agency at least thirty (30) days prior written notice of any proposed amendment or revocation of any provision of this article.

Section 2. Effective Date.

This ordinance shall become effective fifteen (15) days after its adoption and publication.

Adopted: January 22, 1996
Published: February 7, 1996

Publish February 7, 1996 (7).

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to MICHIGAN STATE HOUSING DEVELOPMENT AUTHORITY, a public body, corporate and politic by an assignment dated January 17, 1995, and recorded on March 9, 1995, in Liber 1681, on page 976, BERRIEN County Records, Michigan and re-recorded on July 12, 1995, in Liber 1699, page 259, BERRIEN County Records, Michigan, on which mortgage there is claimed to be due at the date hereof the sum of FORTY TWO THOUSAND THREE HUNDRED THIRTY ONE DOLLARS AND 82 CENTS ($42, 331.82), including interest at 7.650% per annum.

Under the power of sale contained in said mortgage and the statute in such case made and provided, notice is hereby given

such sale, unless abandoned in acc 1948CL 600.3241 case the redemptio be 30 days from the sale.

Dated: January
MICHIGAN STA
DEVELOPMENT A
FOR INFO
PLEASE CALL: 4202
Trott and Trott, F
Attorneys and C
30300 Telegrapl 201
Bingham Farm 48025
File #95125173

Publish January 24(3), 31(2), Fel 1996.

MORTGAGE SALE- Default has been made in the conditions of a mortgage made by MELISSA E. MANDARINO, a single woman to BANC ONE FINANCIAL SERVICES, INC., mortgagee, dated August 25, 1993 and recorded on August 27, 1993 in Liber 1592, on page 635, BERRIEN County Records, Michigan, on which mortgage there is claimed to be due at the date hereof the sum of SEVEN THOUSAND AND SEVENTY EIGHT 28/100 Dollars ($7,078.28), including interest at 15.99% per annum.

Under the power of sale contained in said mortgage and the statute in such case made and provided, notice is hereby given that said mortgage will be foreclosed by a sale of the mortgaged premises, or some part of them, at public vendue, at the front door of the Courthouse in the City of St. Joseph, Berrien County, Michigan, at 10:00 o'clock a.m. on March 21, 1996.

Said premises are situated in City of Stevensville, BERRIEN County, Michigan, and are described as:

Parcel 1: Lot 10, Summerset Estate, being a subdivision in Section 16, Township 5, South,

Range 19 West, the plat thereof gust 6, 1957, in Plats, Page 41.

Parcel 2: Lot 1 Estates No. 2, be sion in part of th Fractional Quart 16, Township 5 19 West, accordi thereof recorde 29, 1967, in Boo Page 25.

Also the weste lots 10 and 11, S tates.

11-12-7310-00
11-12-7310-00

The redemption be 6 months from such sale, unless abandoned in acc 1948CL 600.3241 case the redemptio be 30 days from th sale.

Dated: January
BANC ONE SERVICES, INC. M
MICHAEL M. G neys
Suite 264W
31731 Northwes
Farmington Hills
Publish Februar 21(5), 28(3), March

Sec. 38-95. Updates.

By amendment of this Article, the boundaries of a Designated Area may be enlarged or decreased, or a Designated Area may be added, modified, or repealed, in light of data about the extent and severity of groundwater contamination in the City and relevant law and environmental and health standards.

Sec. 38-96. Modification or Repeal of this Article; Notice to the State of Michigan.

If modification or repeal of this Article would allow the use of a groundwater well for human consumption in a Designated Area, then the City shall notify the Michigan Department of Environmental Quality no less than 30 days in advance of such modification or repeal.

Sec. 38-97. Penalty.

Any person found guilty by a court of competent jurisdiction of violating any provision of this Article shall be punished as provided in Section 1-15 of this Code. Each day that a violation of this Article continues shall constitute a separate offense. Upon application to any court of competent jurisdiction, the court may order the violation restrained and enjoined. The cessation of the activity that violates this Article shall not preclude enforcement of this Article by complaint for violation of this Article and the imposition of punishment under Section 1-15 of this Code. No permit for building, alteration, or other required permit for a premises or improvement thereon shall be issued by the City for any premises found in violation of this Article, or where it is proposed to install or use a well in violation of this Article.

Sec. 38-98. Separability.

If any part of this Ordinance is held invalid or unenforceable by a court having jurisdiction, then said determination shall not affect the validity of the remaining provisions.

Sec. 2. Effective Date. This Ordinance shall become effective twenty (20) days after its adoption and publication.

ADOPTED: ____________________

PUBLISHED: ____________________

26557.01

and south along Shirmer Parkway to its intersection with Front Street, then west along Front Street to its intersection with Redbud Trail.

2. ElectroVoice Plume area, consisting of: (a) the McCoy Pond Park, and (b) all properties wi'hin the area bounded as follows: Beginning at the intersection of Carroll Street and Redbud Trail, proceding north along Redbud Trail to its intersection with Chicago Street, then west along Chicago Street to its intersection with Days Street, then north along Days Street to its intersection with Front Street, then west along Front Street to its intersection with Main Street, then north along Main Street to its intersection with Third Street, then east along Third Street to its intersection with Redbud Trail, then south along Redbud Trail to its intersection with Front Street, then east along Front Street to its intersection with Liberty Street, then south along Liberty Street to its intersection with Carroll Street, then west and northwest along Carroll Street to its intersection with Redbud Trail.

The Designated Areas are depicted on the attached map. In the event of a discrepancy between the map and the description set forth in this Article, the description in this Article governs.

Sec. 38-93. Wells Affecting Contaminated Groundwater.

No well may be used or installed in the City if the use of such well will cause the migration of groundwater contaminants, pollution, or a groundwater plume containing contaminants, to previously unimpacted groundwater, or will cause an adverse impact on any groundwater treatment system, unless such well is part of a groundwater investigation, monitoring or remediation system approved by the United States Environmental Protection Agency or the Michigan Department of Environmental Quality.

Sec. 38-94. City Inspections; Enforcement.

The City shall annually canvass or inspect all affected properties in Designated Areas where it is suspected that a well or secondary water supply is being used as a source for water for human consumption or other prohibited uses, and shall notify by appropriate means the owners and occupants thereof to disconnect and disable, in accordance with legal requirements, the use of any such well.

Exception: Water service unavailable. Groundwater from a well in a Designated Area may be used if City water service is unavailable at the premises, the well at that premises is sampled and found to provide groundwater that meets state criteria for usage of groundwater for residential purposes, and such well is tested and found to meet such state criteria annually, with proof submitted to the City Manager. Property shall not be split or conveyed so as to render City water service unavailable.

Exception: Proof of No Influence; Waiver. The City Manager may execute a waiver allowing the use of groundwater from a well on a premises in a Designated Area if the well on the premises is demonstrated to be free of the influence or potential influence of excessively contaminated groundwater emanating from a contaminated site. This exception includes, but is not limited to, property located within the same City block as a plume of excessively contaminated groundwater but determined to be permanently unaffected by the course of the affected groundwater.

Exception: Noncontact Cooling or Process Water. This Article does not prohibit the use of groundwater from a well in a Designated Area for noncontact cooling water or processing for manufacturing or commercial activities, if such use is approved by the Michigan Department of Environmental Quality or other government agencies with jurisdiction.

Exception: Public Emergencies and Construction Dewatering. This Article does not prohibit the use of a well in a Designated Area for public emergencies or construction dewatering purposes.

Exception: Environmental Investigation, Monitoring, and Remediation Wells. This Article does not prohibit use of a well in a Designated Area for purposes of environmental investigation, monitoring, or remediation.

Sec. 38-92. Designated Areas.

The Designated Areas are as follow:

1. McCoy Creek Industrial Park area, consisting of all properties within the area bounded as follows: Beginning at the intersection of Front Street and Redbud Trail, proceding north on Redbud Trail to its intersection with River Street, then northeast along River Street to its intersection with Shirmer Parkway, then southeast

CITY OF BUCHANAN
BERRIEN COUNTY, MICHIGAN

ORDINANCE NO. ____

AN ORDINANCE AMENDING CHAPTER 38 OF THE CODE OF ORDINANCES TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH, SAFETY AND WELFARE BY PROHIBITING THE USE OF GROUNDWATER IN DESIGNATED AREAS; AND PROVIDING A PENALTY FOR THE VIOLATION THEREOF

THE CITY OF BUCHANAN ORDAINS:

Section 1. Amendment of Article IV to Chapter 38.

Article IV to Chapter 38 (Environment) of the Code of Ordinances, City of Buchanan, Michigan, is amended by repealing all existing text of Article IV to Chapter 38 and adding new text as follows:

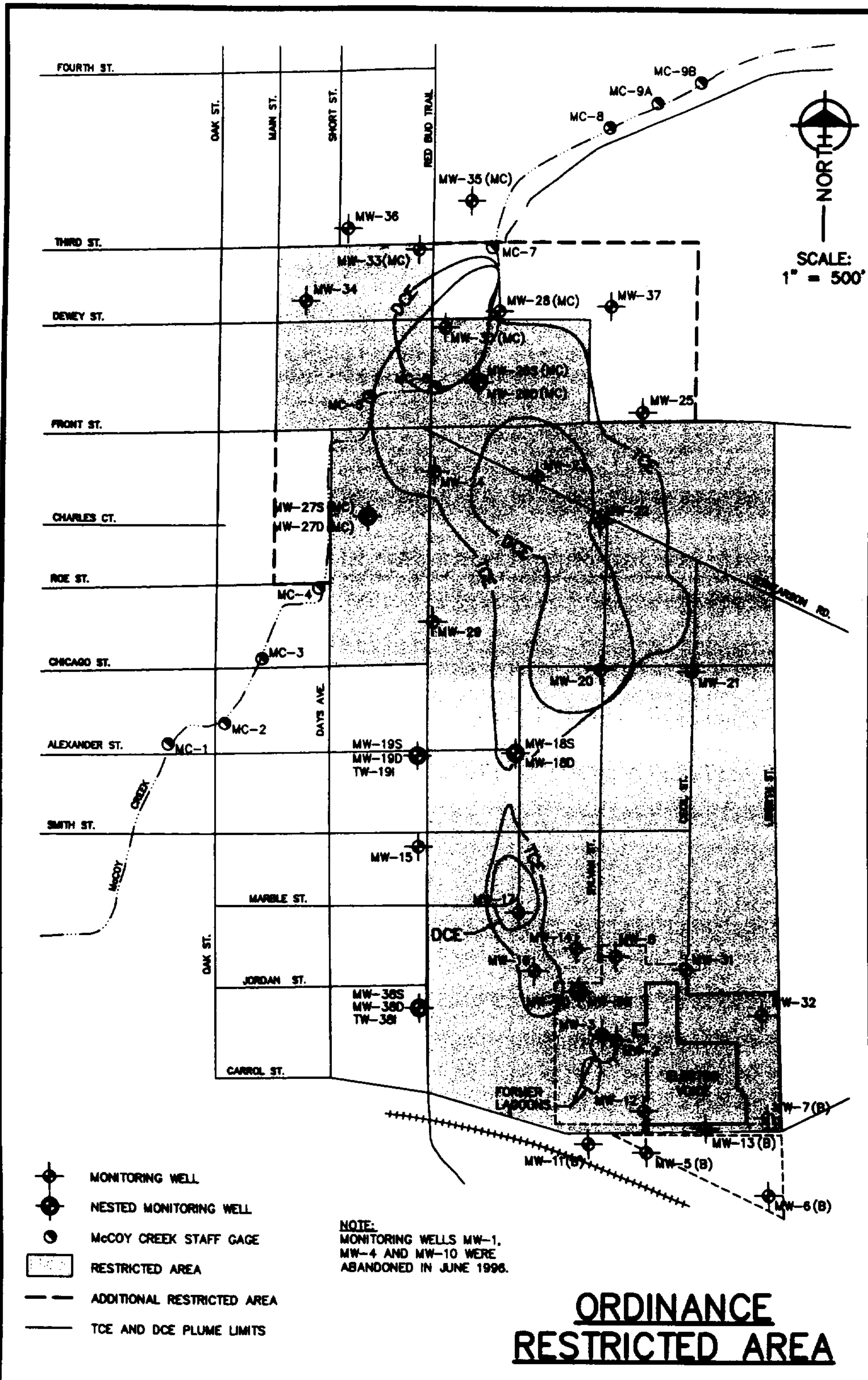
ARTICLE IV - GROUNDWATER PROTECTION.

Sec. 38-90. Purpose and Policy.

This Article imposes institutional controls to protect the health of the residents of the City from groundwater that has been identified as being excessively contaminated according to criteria of a state or federal environmental regulatory agency. The institutional controls consist of prohibitions on the use of groundwater in designated areas of the City, exceptions to those prohibitions, and additional provisions necessary to carry out this Article. It is intended that the designated areas will (a) encompass areas in which excessive groundwater contamination has been identified and in which institutional controls are believed to be appropriate, (b) be identified by boundaries corresponding to City streets or other readily identifiable landmarks so that properties within the designated areas may be readily identified, and (c) be readily capable of amendment. This Ordinance is to be published and maintained in the same manner as a zoning ordinance.

Sec. 38-91. Prohibition on Groundwater Removal; Exceptions.

Prohibition. The use of any groundwater from a well located in a Designated Area is prohibited, except as expressly stated in this Article. This prohibition includes groundwater from all soil depths and strata in a Designated Area, except as expressly stated in this Article.



ORDINANCE RESTRICTED AREA

Fishbeck, Thompson, Carr & Huber
Engineers • Scientists • Architects
Grand Rapids, Michigan

ftch

ELECTRO-VOICE SITE
BUCHANAN, MICHIGAN

OFF-PROPERTY GROUNDWATER TECHNICAL MEMORANDUM

PROJECT NO.
93307S

FIGURE NO.
1

DECLARATION OF RESTRICTION ON REAL PROPERTY

THIS DECLARATION OF RESTRICTION ON REAL PROPERTY is executed this 12th day of January, 1994 by Mr. and Mrs. Clyde Wolkins, husband and wife, of 308 Rynearson, Buchanan, MI 49107 (individually or collectively, "Owner").

Recitals

A. Owner is the titleholder of certain real property situated in the City of Buchanan, County of Berrien, State of Michigan and legally described on the attached Exhibit A (the "Property").

B. According to the Record of Decision ("ROD") issued by the United States Environmental Protection Agency ("U.S. EPA") dated June 23, 1992, the groundwater beneath the Property is or may be affected by contaminated substances migrating to the Property from certain real property commonly known as 600 Cecil Street, owned by Electro-Voice, Inc., a Michigan corporation ("Electro-Voice").

C. In a Consent Decree entered by the Federal District Court for the Western District of Michigan on December 21, 1993, U.S. EPA required Electro-Voice to obtain this restriction on the use of groundwater under the Property.

Provisions

Owner agrees as follows:

1. Restriction. Owner shall not install a water well on, use any existing well on, or pump or otherwise use any groundwater from beneath the surface of the Property or permit anyone else to do so.

2. Owner. Owner represents that the person(s) signing this document are the only owners of the Property.

3. Binding Effect. This restriction is binding on Owner and all other persons and entities acquiring any interest in the Property and shall run with the Property.

4. Termination. This Declaration may be terminated upon appropriate action or agreement, including by not limited to the following:

   a) U.S. EPA or its successor approves the completion of all remedial action work and achievement of all clean up standards at the Electro-Voice property and beneath the Property as set forth in the ROD; or

b) U.S. EPA or its successor shall execute and record in the office of the Berrien County Register of Deeds a document permitting the termination of this Declaration.

Owner has executed this document as of the date first above written.

WITNESSES:

Minnie Warren
*MINNIE WARREN

~~NFHe~~ N F Heino
* N. F HEINO

OWNER:

Beatrice Wolkins
*~~CLYD~~ BEATRICE WOLKINS

CLYDE WOLKINS deceased March 9, 19
*

STATE OF Michigan)
) ss.
COUNTY OF Berrien)

The foregoing instrument was acknowledged before me this 12th day of January, 1994 by BEATRICE WOLKINS.

N F Heino
*
Notary Public
Berrien County, Michigan
My commission expires: 6-1-94
NORMAN FREDERICK HEINO
NOTARY PUBLIC – BERRIEN COUNTY, MICH.
MY COMMISSION EXPIRES 6-1-94

*Print or type name beneath signature line.

DRAFTED BY AND AFTER RECORDING RETURN TO:

BRUCE GOODMAN
Varnum, Riddering,
Schmidt & Howlett
P.O. Box 352
Grand Rapids, MI 49503-0352
(616) 336-6000

EXHIBIT A

Mr. and Mrs. Clyde Wolkins

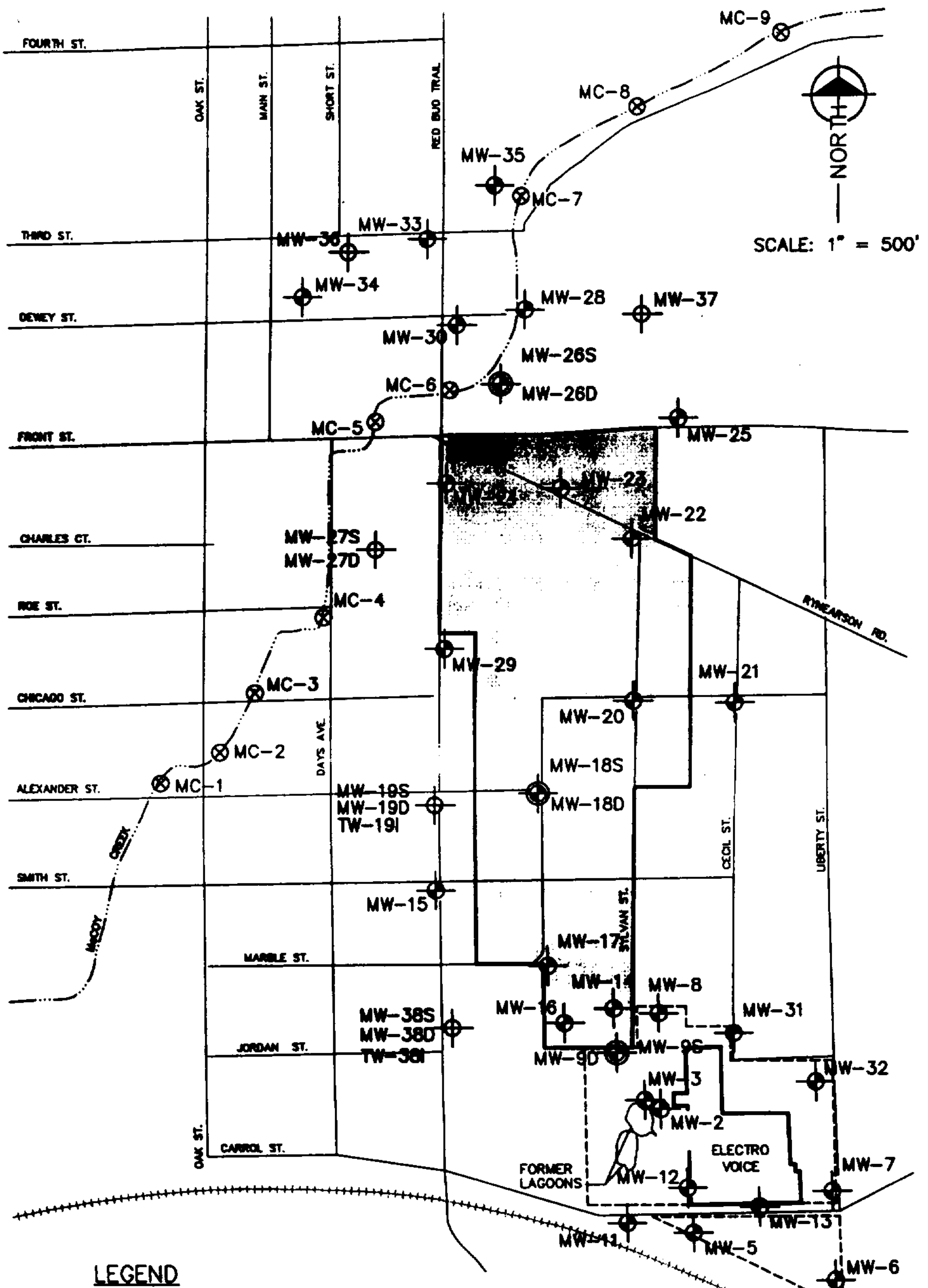
That certain piece or parcel of land located in the City of Buchanan, County of Berrien, and State of Michigan described as

Com. at the N.W. corner of Sec. 36, Twp. 7 S. R. 18 W., thence South 40 feet, thence S. 66° 18' E. 255.5 ft. to beg.; th. S. 22° W. 136 feet; th. S. 66° 18' E. 73.5 feet; th. N. 22° E. 136 feet; th. N. 66° 18' W. 73.5 feet to the place of beg.

Com. at the N.W. corner of Sec. 36, Twp. 7 S., R. 18 W., th. S. 40 ft., th. S. 66° 18' E. 456 feet to beg.; th. S. 66° 18' E. 86 feet; th. S. 24° W. 139 feet; th. N. 66° 18' W. to the E. line of the Michigan Central Railroad; th. NEly along the railroad, 137 feet to the place of beg.

This deed is rec. to correct an error in descn. contained in the deed from the same Grantors to the same Grantees as contained herein, and rec. at Liber 355 of Deeds, page 621.

Lot 246 ?



LEGEND

MW-6 MONITOR WELL

MW-9S / MW-9D NESTED MONITOR WELL

MC-2 McCOY CREEK STREAM ELEVATION GAGE

MW-38 PROPOSED MONITOR WELL / TW-TEMPORARY WELL

AREA OF REQUESTED GROUNDWATER USE RESTRICTIONS

fishbeck, thompson, carr & huber
engineers • scientists • architects
Ada • Lansing • Kalamazoo
Michigan

ELECTRO-VOICE SITE
BUCHANAN, MICHIGAN

OFF-PROPERTY GROUNDWATER WORK PLAN

PROJECT NO. 93307S

FIGURE NO. 1

PLOT INFO: 93307S\CD\33075S06.DWG DATE: 08/23/1998 TIME: 9:42 AM USER: DSM

ATTACHMENT 3

Modeling Calculations Used to Estimate Cleanup Time Frames

Appendix B
Equations Used in Extraction Well Calculations

Appendix B
EQUATIONS USED IN EXTRACTION WELL CALCULATIONS

INTRODUCTION

This appendix discusses the data used and assumptions made in evaluating the remedial action alternatives for groundwater for the Electro-Voice site. Alternatives considered were:

1. No action
2. One onsite extraction well with natural attenuation downgradient of the site
3. One onsite extraction well and additional downgradient extraction wells near McCoy Creek

The yield of individual wells will depend on the hydraulic conductivity and saturated thickness of the aquifer. The drawdown and capture zone of multiple extraction wells will be influenced by the drawdown of each individual well, well spacing, and the proximity of impermeable or constant head boundaries to the wells. It is assumed extraction wells will partially penetrate the aquifer, will be 6 inches in diameter, and will have a 5-foot-long screen.

SPECIFIC GRAVITY

Estimates of specific capacity were used to determine well yields. Specific capacity is defined as the yield of a well per foot of drawdown and was calculated using the following equation (Todd 1980):

$$Q/S_w = 1/[(2.30/4\pi T)\log(2.25Tt/r_w^2S) + CQ^{n-1}]$$

where:

Q/S_w = specific capacity (gpd/ft)
T = transmissivity of the aquifer (ft^2/day)
t = time since pumping began (days)
r_w = radius of the well (feet)
S = specific yield of the aquifer (decimal percent)
CQ^{n-1} = well loss (ft/gpd)

The term CQ^{n-1} was assumed to be equal to zero.

To estimate the specific capacity, a well radius of 0.25 foot was assumed along with a time of 365 days and a specific yield of 0.20. Transmissivity is equivalent to the product of the hydraulic conductivity and the saturated thickness of the aquifer (original saturated thickness minus the drawdown at the well). The hydraulic conductivity value used for the onsite well was 116 feet/day (866 gpd/ft^2). This value is the log average of the hydraulic conductivities obtained during slug tests of the following wells near or within the onsite VOC plume: MW-9S/9D, MW-10, MW-8. For the downgradient well near McCoy Creek, the hydraulic conductivity value used was 82.6 feet/day (620 gpd/ft^2) and was the log average of hydraulic conductivity values obtained for wells MW-24 and MW-26S/26D. A range of drawdowns was used to estimate the specific capacity. The results of the calculations along with the extraction well yields are summarized in Table B-1.

The equation above was used in this study to obtain approximate values for specific capacity. Only by conducting a pump test at the site can accurate values be obtained.

CAPTURE ZONE AND WELL SPACING

To calculate the area producing inflow to the extraction wells in a uniform field (capture zone) and to determine well spacings, the following equations (Todd 1980) were used:

$$y_L = \pm Q/2Kbi \qquad \text{(B-1)}$$

where:

y_L = width of the area contributing flow to the well
Q = flow rate of the well
K = hydraulic conductivity of the aquifer
b = saturated thickness of the aquifer
i = hydraulic gradient over the zone of interest

and:

$$x_{sp} = -Q/2\pi Kbi \qquad \text{(B-2)}$$

where:

x_{sp} = the stagnation point downgradient of the extraction well

Table B-2 lists the results for both the onsite and offsite extraction wells using Equations 1 and 2.

To choose the appropriate pumping rate for each extraction well, different pumping rates with their respective drawdowns were substituted into equations B-1 and B-2. The maximum width of the onsite plume is about 300 feet; therefore, the boundary width (y_L) should be at least 300 feet. However, an additional 30 percent was added to that number as a precautionary measure, giving a boundary width of 390 feet. At 8 gpm, y_L is ±166 feet for a total width of 332 feet. This is less than the desired width of 390 feet. At 10 gpm y_L is ±230 feet, for a total width of 460 feet. Thus, a pumping rate of 10 gpm was chosen as the optimum pumping rate for the onsite extraction well.

Table B-1
Specific Gravity and Well Yield

Drawdown (ft)	Saturated Thickness (ft)	Transmissivity (gpd/ft)	Specific Yield (gpm/ft)	Well Yield (gpm)
Onsite Extraction Well				
1	11	9,500	4.0	4
2	10	8,700	4.0	8
3	9	7,800	3.3	10
4	8	6,900	3.0	12
5	7	6,100	2.6	13
Downgradient Extraction Well				
1	14	8,660	4.0	4
2	13	8,040	3.5	7
3	12	7,420	3.3	10
4	11	6,800	3.0	12
5	10	6,190	2.8	14

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Table B-2
Calculated Values for X_{sp} and Y_L

From Equations 1 and 2

Well	$Q, ft^3/s$	K,ft/s	b,ft	i	X_{sp},ft	Y_L,ft
onsite	0.022	1.34×10^{-3}	9	0.004	-73	±230
offsite	0.0267	9.57×10^{-4}	11	0.012	-34	±110

From Equation 3
Onsite Extraction Well

r	change in h due to pumping	change in h due to i	h
1	10.68	0.0	10.68
10	11.23	0.04	11.19
20	11.39	0.08	11.31
30	11.44	0.12	11.34
40	11.54	0.16	11.38
50	11.59	0.20	11.39
60 (X_{sp})	11.63	0.24	11.39
70	11.67	0.28	11.39
80	11.70	0.32	11.38
230 (Y_L)	11.91	0.0	11.91

The following values were used in the recharge equation:
Q_w = $0.022\ ft^3/s$ (10 gpm)
W = 2.64×10^{-8} ft/s (10 in/yr)
r_o = 515 ft.
K = 1.34×10^{-3} ft/s
h_o = 12 ft.

Downgradient Extraction Well

r	change in h due to pumping	change in h due to i	h
1	13.16	0.0	13.16
10	13.91	0.12	13.79
20	14.13	0.24	13.89
30 (X_{sp})	14.25	0.36	13.90
35	14.31	0.42	13.89
40	14.35	0.48	13.87
110 (Y_L)	14.65	0.0	14.65

The following values were used in the recharge equation:
Q_w = $0.0267\ ft^3$ (12 gpm)
W = 2.64×10^{-8} ft/s (10 in/yr)
r_o = 567 ft.
K = 9.57×10^{-4} ft/s
h_o = 15 ft.

Downgradient of the site and near the creek, the maximum width of the plume is approximately 650 feet. Adding 30 percent gives a total width of 845 feet. If it is assumed one extraction well would pump at 12 gpm, 5 wells would be needed (for a total of 60 gpm) to capture the entire plume. Each well would have a y_L of ±105 feet. The line of wells would provide a total boundary width of 892 feet.

To check the values calculated for the boundary widths and stagnation points, another equation was used that takes into account recharge to the aquifer (Todd 1980):

$$h_o^2 - h^2 = (W/2K)(r^2 - r_o^2) + (Q_w/\pi K)(\ln r_o/r) \qquad \text{(B-3)}$$

where:

h_o = initial saturated thickness of the aquifer
h = saturated thickness of aquifer at a given distance, r, from well
r = distance from well where the saturated aquifer is a thickness, h
r_o = distance from well at which there is zero drawdown
W = recharge rate
K = hydraulic conductivity of the aquifer
Q_w = flow rate of well

The equation was used to calculate r, which corresponds to the stagnation point, x_{sp}. When h_o = h, r_o = r. Thus, r_o could be determined using the equation:

$$Q_w = \pi r_o^2 W \qquad \text{(B-4)}$$

where:

$$r_o = (Q_w/\pi W)^{1/2} \qquad \text{(B-5)}$$

To calculate r_o, a recharge rate of 10 inches/year was assumed. The pumping rate was 0.022 ft^3/s (10 gpm) for the onsite extraction wells and 0.0267 ft^3/s (12 gpm) for the offsite extraction wells. The recharge rate was obtained from the RI report; EV reported a recharge rate of 12 inches/year with somewhat less recharge in the paved city areas. The values for r_o was 515 feet for the onsite extraction wells and 567 feet for the offsite extraction wells.

Once r_o was determined, different values of r were chosen and substituted into the equation. For each r, a corresponding value for h was calculated. As the distance from the well increased, drawdown decreased and the effect from the hydraulic gradient (i) increased. The value for i at each distance r was determined and subtracted from the corresponding value for h. This gave an h value corrected for the hydraulic gradient. Values for h increased downgradient until some distance r (the stagnation point) was reached; h then began to decrease. The distance r at which h reached its maximum value corresponds to the stagnation point, x_{sp}.

Equation B-3 was also used to calculate the width of the area contributing flow to the well, y_L. In this situation, the hydraulic gradient was assumed to be equal to zero since y_L is perpendicular to the flow direction.

Equation B-3 gave slightly lower values for x_{sp} and indicated the values calculated for y_L were reasonable. Table B-2 includes the values calculated for x_{sp} and y_L using Equation B-3. The locations of the onsite and offsite extraction wells along with each well's capture zone is depicted in Figure B-1, following page 4.

PORE VOLUME EXCHANGE CALCULATIONS

The pore volume exchange time (t_d) for the general mass of the water to move through the aquifer once was estimated using the equation:

$$t_d = V/Q$$

where:

V = volume of the area to be remediated
Q = pumping rate of the extraction well

For the onsite extraction well, the total area to be remediated extends from a point 100 feet downgradient of MW-2 to 200 feet upgradient of MW-2 giving a total length of 300 feet (Figure B-2, following page 4). The average width is 265 feet. An average saturated thickness of 12 feet and an effective porosity of 20 percent were assumed for this calculation, yielding a volume of 191,000 cubic feet. The pumping rate was 1.33 ft^3/min (10 gpm). From these values, a pore volume exchange time of about 99 days (0.27 year) was calculated.

For the multiple extraction wells at McCoy Creek, the area to be remediated extended from just north of the onsite extraction well to the creek (a length of 2,500 feet) with an average width of 736 feet and an average saturated thickness of 42 feet (Figure B-3, following page 4). A porosity of 20 percent was also assumed. This gave a volume of 1.55×10^7 ft^3. The total pumping rate was assumed to be 60 gpm (five wells at 12 gpm each). The resulting calculated pore volume exchange time was approximately 3.7 years.

In the case of natural attenuation, a volume of 1.55×10^7 ft^3 was also used. To calculate Q, it was assumed that all groundwater flow enters McCoy Creek. Although the VOC plume depicted in Figure B-4, following page 4, does extend beyond the creek, it does so for only a short distance. As the groundwater contours indicate, that portion of the plume eventually discharges to the creek. A transect line (D-D') was drawn near McCoy Creek (Figure B-4, following page 4) and divided into five flow channel. A cross section is presented in Figure B-5, following page 4. Q was calculated for each of the flow channels using Darcy's equation:

$$Q = KAI$$

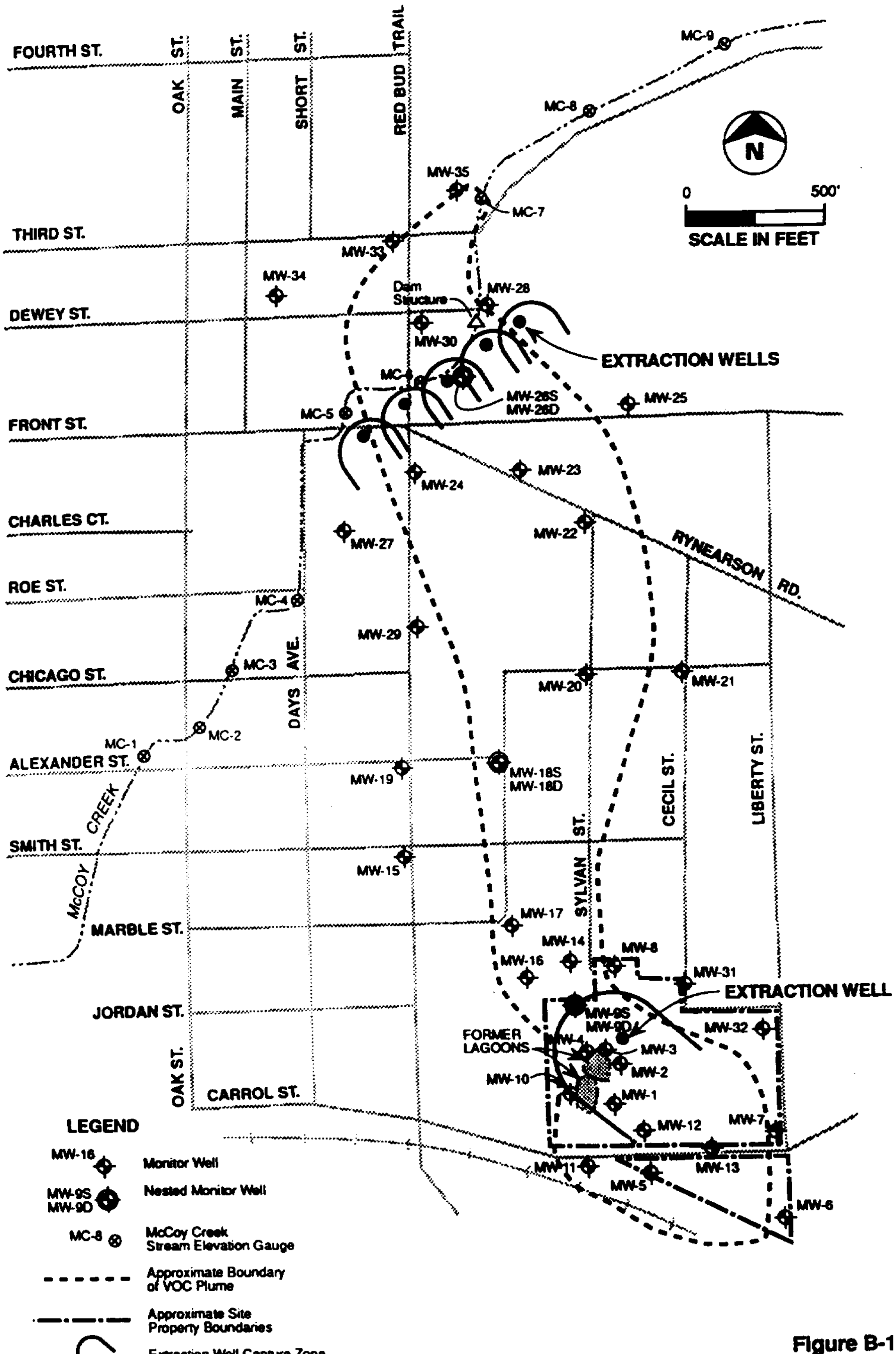

Figure B-1
Extraction Well Locations
Electro-Voice, Inc. FS

GLO65601.FS Extraction Well Loc 7-2-91mms

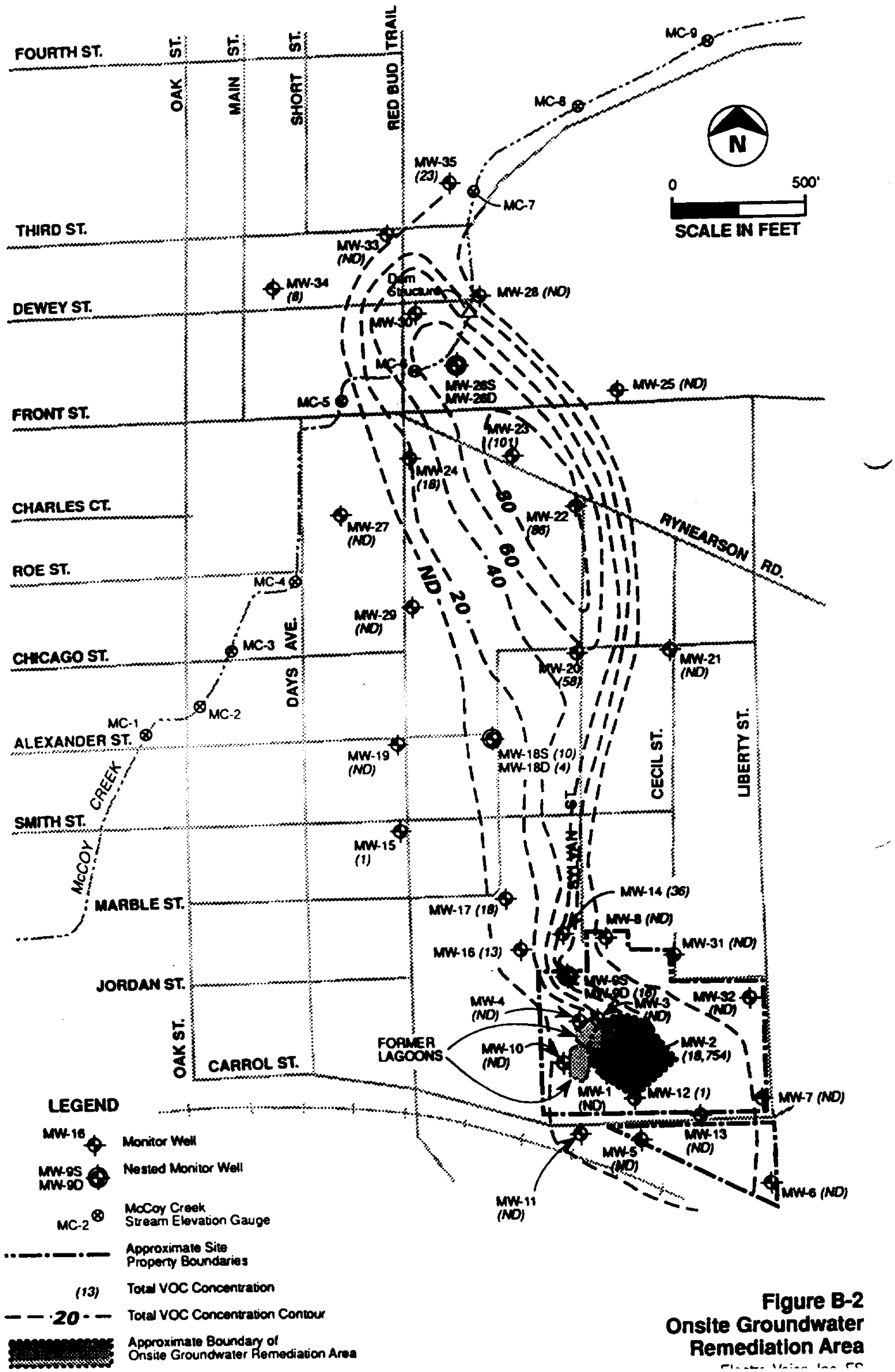

Figure B-2
Onsite Groundwater Remediation Area

GLO65560 1.FS Onsite GW Remed 7-2-91mms

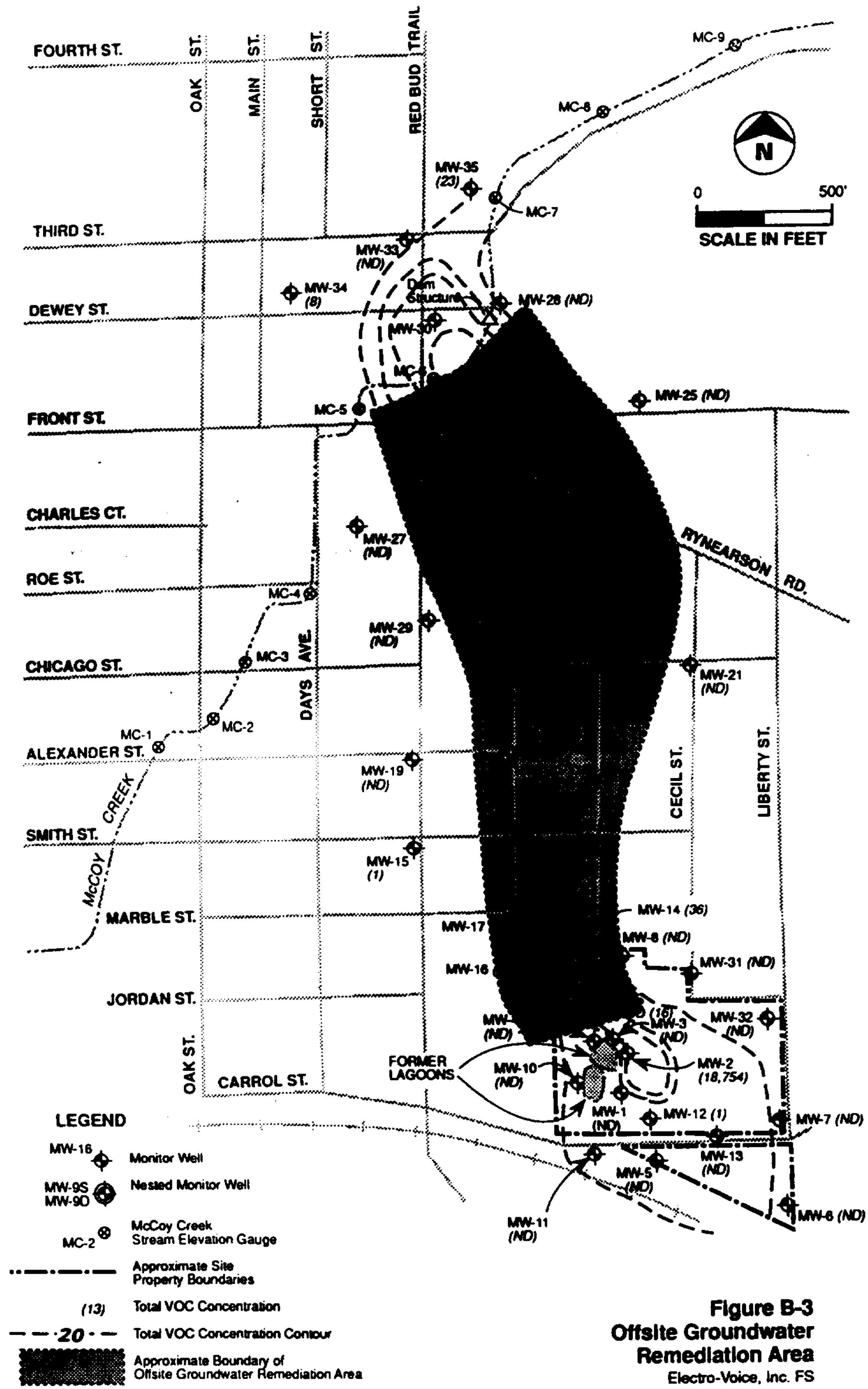

Figure B-3
Offsite Groundwater Remediation Area
Electro-Voice, Inc. FS

GLO65560I.FS OFFSITE GW Remed 7-2-91mms

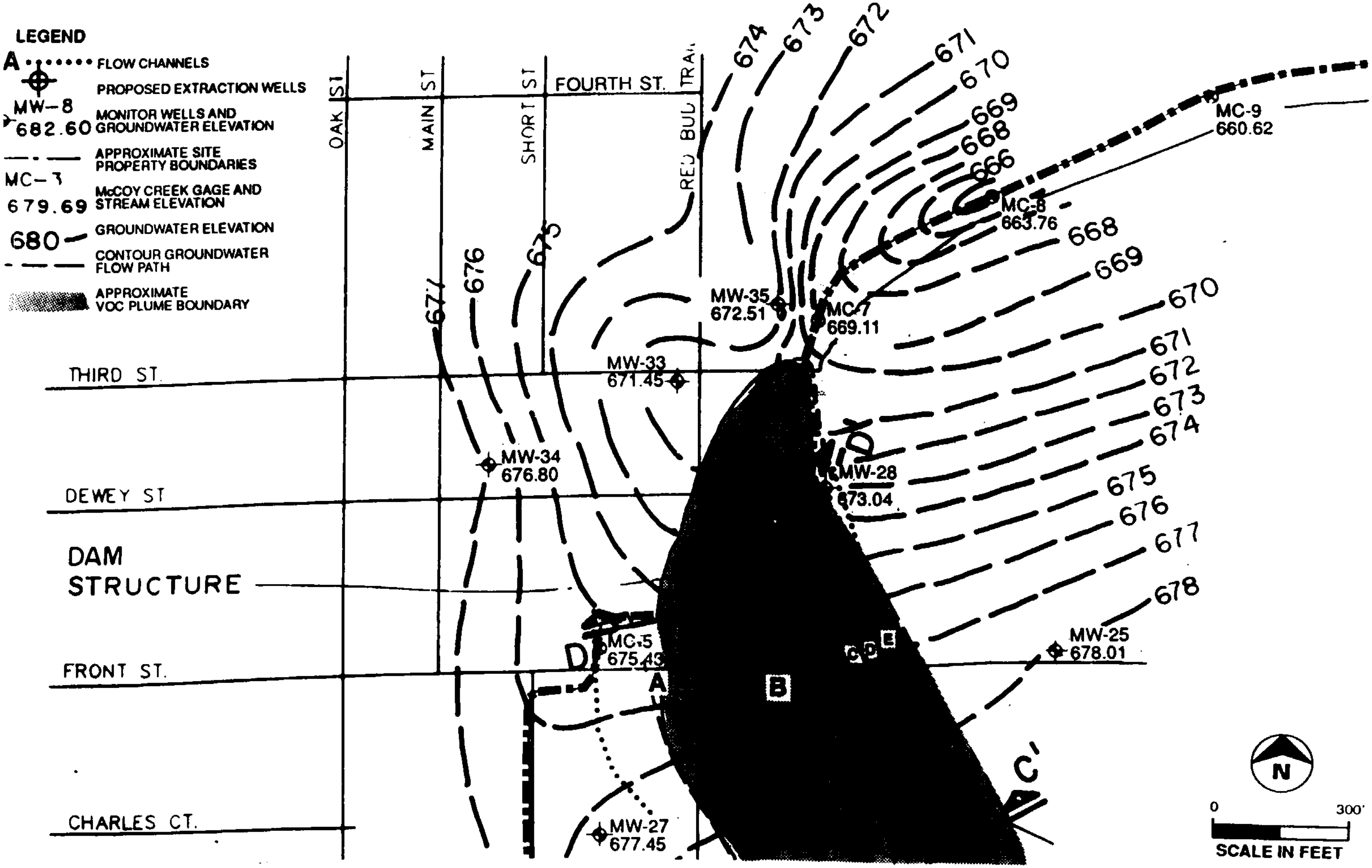

Figure B-4
Groundwater Contour Map With VOC Plume and Transect Lines

SOURCE: Figure 1, *Electro-Voice FS*, FTC&H Engineers & Scientists, GLO65601.FS X-SECT D-D' 7-1-91mms

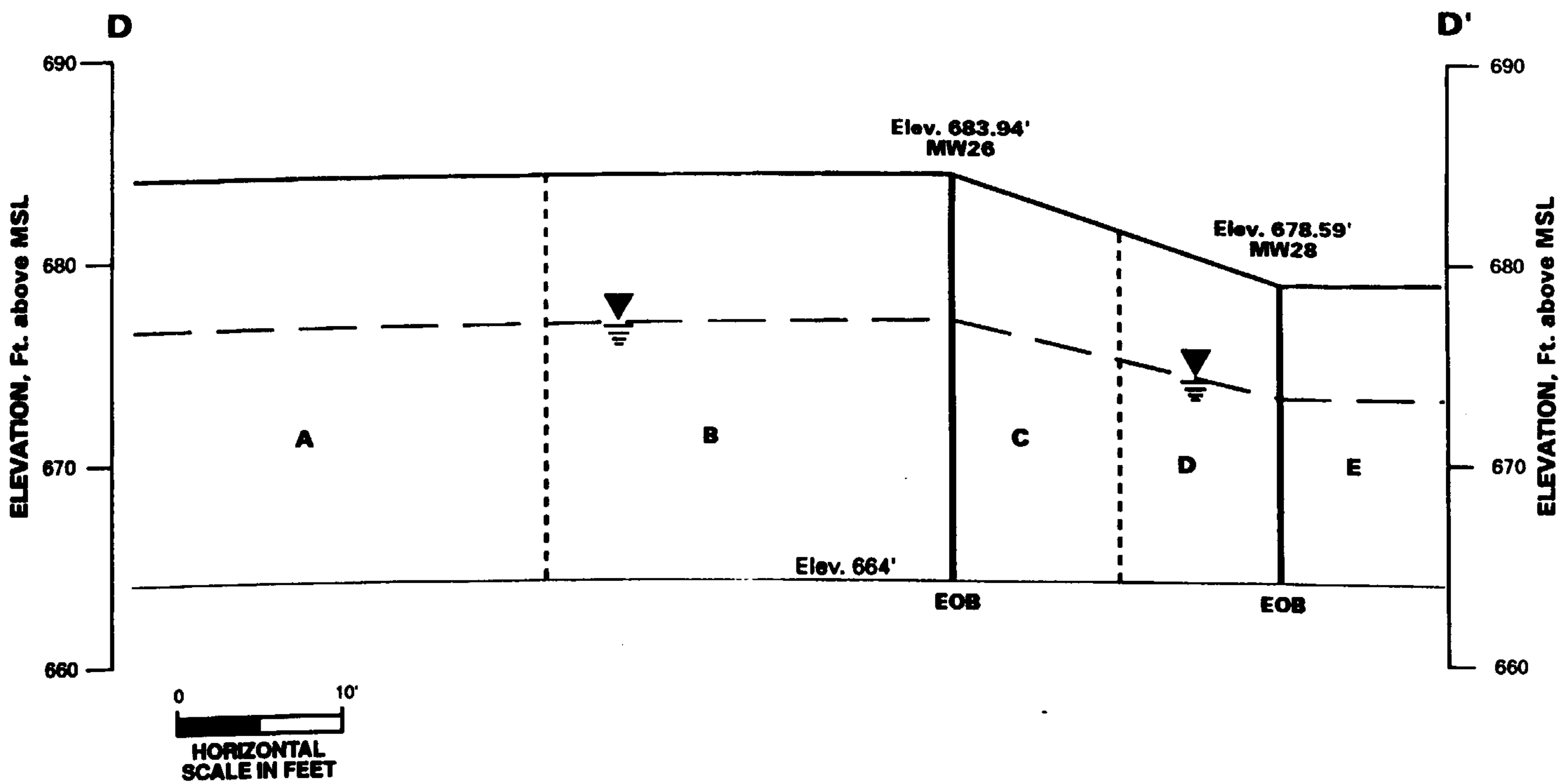

Figure B-5
Cross Section
Along Transect Line D-D'
Electro-Voice, Inc. FS

where:

Q = quantity of water per unit time flowing through a unit cross section of area A
K = hydraulic conductivity of the aquifer
A = cross-section through aquifer
I = hydraulic gradient

The hydraulic gradient for each flow channel was calculated using the three groundwater contours just downgradient of the creek in that particular channel. A value for Q was calculated for each flow channel (Table B-3) and the values summed to come up with a total Q of 39,400 gpd or 27 gpm. Using these values, a pore volume exchange time of 8.1 years was calculated.

ESTIMATED CLEANUP TIMES

Remedial action goals used in estimating cleanup times are presented in Table 3-4. Where available, 10^{-6} risk-based criteria were used. Where values were not available, MDNR's HLCSCs were used. In calculating cleanup times, it was assumed that the source would be removed completely.

The following equation was used to calculate groundwater cleanup times (see Attachment 1 for the derivation of this equation):

$$pv_{conc} = o_{conc} \times e^{(-\ln[R/R\text{-}1])} \times npv$$

where:

pv_{conc} = concentration in groundwater remaining after n pore volumes have been removed
o_{conc} = original concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

Two cleanup times were estimated for TCE downgradient of the site. TCE was the compound mainly responsible for the plume near the creek. Because the highest concentrations were in a relatively narrow band, the cleanup time was calculated using both the maximum observed concentration (76 ppb) and then by averaging the concentration over the whole downgradient area. This gave an average concentration of 15 ppb.

It is important to remember that the TCE concentration of 15 ppb is only an average of that compound over the downgradient portion of the aquifer to be remediated. Therefore, some sections of the aquifer will have considerably higher concentrations of TCE. A more conservative estimate for cleanup time is obtained when using the maximum observed concentration of 76 ppb. Even then, it is possible TCE concentrations higher than 76 ppb exist downgradient of the site.

The following tables list the cleanup times for each compound. Table B-4 presents the cleanup times for each compound with one onsite extraction well and natural

Table B-3
Flow Channel Fluxes

Section	Area (ft^2)	Gradient	Flux, Q (gpd)
A	3,000	0.008	10,536
B	3,000	0.012	15,804
C	1,160	0.011	5,602
D	990	0.009	3,911
E	900	0.009	3,556

Note:
The value for the hydraulic conductivity used in the above calculations was 439 gpd/ft^2 (58.7 ft/day). This value was the log average of hydraulic conductivities derived from slug tests of wells in the vicinity of the creek.

attenuation allowed to occur downgradient. Table B-5 gives cleanup times for three compounds detected downgradient of the site assuming five extraction wells are located near McCoy Creek. Table B-6 lists cleanup times for each compound based on the no-action alternative. Attachment 2 provides tables for each compound listing the concentration remaining for each pore volume of water removed.

REFERENCES

Todd, D. K. *Groundwater Hydrology,* 2nd ed. New York: John Wiley & Sons. 1980.

U.S. Environmental Protection Agency. *Western Processing Feasibility Study,* Appendix F. 1985.

GLT181/017.51

Table B-4
Cleanup Times for One Onsite Extraction Well with Natural Attenuation Downgradient

Compound	Cleanup Time (years) Onsite	Downgradient
Benzene	1.5	NA
1,1-DCA	0.5	NA
1,2-DCA	1	NA
1,2-DCE	0.5	8
Ethylbenzene	4	NA
Toluene	2	NA
TCE	2	32 to 65*
Vinyl Chloride	1	24
Xylenes	0.5	NA

Note:
NA Indicates compound not detected downgradient.
* Indicates two initial groundwater concentrations (15 and 76 ppb) were used in estimating cleanup times.

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Table B-5
Cleanup Times Downgradient of Dry Well with Multiple Extraction Wells near McCoy Creek

Compound	Cleanup Time (years)
1,2-DCE	8
TCE	15 to 30*
Vinyl Chloride	11

Note:
The 11-year cleanup time for vinyl chloride was based on its maximum observed concentration of 72 ppb. However, vinyl chloride is a degradation product of TCE and will likely be present for as long as the TCE is present.

* Indicates two initial groundwater concentrations (15 and 76 ppb) were used in estimating cleanup times.

GLT192/054.51

Table B-6
Cleanup Times
No-Action Alternative

Compound	Cleanup Time (years)
Benzene	32
1,1 DCA	16
1,2 DCA	24
1,2 DCE	8
Ethylbenzene	113
Toluene	65
TCE	32 to 65*
Vinyl Chloride	24
Xylenes	16

Note:
* Indicates two initial groundwater concentrations (15 and 76 ppb) were used in estimating cleanup times.

GLT192/055.51

ATTACHMENT 1

ATTACHMENT 1

INTRODUCTION

The following equation:

$$pv_{Conc} = o_{Conc} \times e^{(-\ln(R/R-1))} \times npv$$

was used to estimate cleanup times. The derivation of the equation (CH2M HILL 1985) follows. It incorporates the following assumptions:

- Effective porosity is 20%.
- Contaminants are uniformly distributed.
- Pumping is uniform throughout the remediation area.

MASS BALANCE EQUATIONS

The derivation of the equations used in the mass balance approach is as follows:

Let:

Total mass of contaminant = TMCONT
Mass of soil contaminant = MCSOIL
Mass of groundwater contaminant = MCGW
Density of soil = ρs
Density of water = ρw (assumed to be equal to 1)
Volume of soil = Vs
Porosity of soil = ηs

By definition:

$$\text{TMCONT} = \text{MCSOIL} + \text{MCGW} \quad (1)$$

and:

$$K_d = (\text{MCSOIL}/(\rho s \times Vs)) \times ((\rho w \times \eta s \times Vs)/\text{MCGW})$$

$$= (\text{MCSOIL}/\text{MCGW}) \times \eta s/\rho s \quad (2)$$

where:

K_d = distribution coefficient

The distribution coefficient is defined as the mass of solute adsorbed or precipitated per unit dry mass of soil per mass of solute in solution per unit volume of water.

The K_d values for several compounds were calculated using the equation:

$$K_d = K_{oc} \times TOC$$

where:

K_{oc} = organic carbon partitioning coefficient

(K_{oc} values were estimated using the *Handbook of Chemical Property Estimation Methods* (Lyman et al. 1982)

TOC = total organic carbon in the aquifer matrix (assumed to be 0.1 percent for a sand/gravel aquifer with low organic content)

In general, compounds with high K_d values tend to be more adsorbed to the aquifer matrix, and thus more retarded. The K_{oc} and K_d values for several onsite compounds are presented in Table 1.

Rearranging Equation 2 yields:

$$MCSOIL = MCGW \times ([K_d \times \rho s]/\eta s) \qquad (3)$$

and:

$$MCGW = MCSOIL \times (\eta s/[K_d \times \rho s]) \qquad (4)$$

Substituting Equation 3 into Equation 1 yields:

$$TMCONT = (MCGW \times [(K_d \times \rho s)/\eta s]) + MCGW$$

$$= MCGW\ (1 + [K_d \times \rho s]/\eta s) \qquad (5)$$

Where:

$1 + (K_d \times \rho s)/\eta s$ is by definition the retardation factor (R).

In calculating the retardation factor (R), a bulk density of 1.85 g/cm^3 was used. This is an average of lab results from soil samples obtained during the RI. Table 1 includes the R values for the compounds.

At each timestep (n), which is equivalent to one pore volume exchange time, the following equations apply:

$$MCGW_{(n+1)} = TMCONT_{(n)}/R \qquad (6)$$

$$MCSOIL_{(n+1)} = TMCONT_{(n)} - MCGW_{(n+1)} \qquad (7)$$

$$TMCONT_{(n+1)} = MCSOIL_{(n+1)} \qquad (8)$$

Table 1
K_{oc}, K_d, and R Values

Compound	K_{oc}	K_d	R
Benzene	95.6	0.0956	1.884
1,1-DCA	46.9	0.469	1.434
1,2-DCA	28	0.028	1.259
1,2-DCE	4.5	0.0045	1.042
Ethylbenzene	1100	1.1	11.175
Toluene	300	0.3	3.775
1,1,1-TCA	152	0.152	2.406
TCE	217	0.217	3.007
Vinyl Chloride	19.4	0.0194	1.179
Xylenes	240	0.24	3.22

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Substituting Equation 4 into Equation 1 and proceeding as above yields:

$$MCSOIL_{(n+1)} = TMCONT_{(n)} \times ([R-1]/R) \quad (9)$$

$$MCGW_{(n+1)} = TMCONT_{(n)} - MCSOIL_{(n+1)} \quad (10)$$

$$TMCONT_{(n+1)} = MCSOIL_{(n+1)} \quad (11)$$

EXPONENTIAL DECAY EQUATION

The relative decrease in mass (or concentration) with time described by Equations 6 through 11 is constant. That is, for each timestep the same ratio of mass is removed from the system but the total mass removed is less. This constant reduction can be described by a first order exponential decay equation of the form:

$$M_t = M_o \times e^{(-at)} \quad (12)$$

where:

M_t = contaminant mass at time t

M_o = initial contaminant mass

a = decay constant (first order)

t = time

(Note: Concentrations may be substituted for mass in Equation 12.)

The decay constant can be calculated as follows:

$$a = \ln(M_o/M_p) \quad (13)$$

where:

M_o = initial total mass of contaminant

M_p = total mass of contaminant remaining in soil after removal of one pore volume of water

Using Equations 6, 7, and 8, M_o/M_p can be written as:

$$M_o/M_p = 1/(1-[1/R]) \quad (14)$$

or using Equations 9, 10, and 11:

$$M_o/M_p = R/(R-1) \quad (15)$$

(Note that Equations 14 and 15 are equal.)

Substituting Equation 15 into Equation 13 yields an expression for the decay constant in terms of the retardation factor:

$$a = \ln(R/(R-1)) \tag{16}$$

Equation 16 can be substituted into equation 9 and corrected for fractional pore volume times to yield:

$$M_t = M_o \times e^{(-\ln[R/(R-1)])} \times (t/\text{pore volume time})$$

or:

$$pv_{Conc} = o_{Conc} \times e^{(-\ln[R/(R-1)])} \times npv$$

The above equation was used to calculate concentration versus time and the fraction remaining for each contaminant of concern. Results for each of these contaminants are presented in tables (see Attachment 2).

GLT181/021.51

ATTACHMENT 2

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant: 1,1 DCA
Koc = 46.9 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0469 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 300 ug/L
Retardation Factor = 1.4338 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 **decimal percent**
Density = 1.85 g/cm3
Pore Volume Time = 0.27 **years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	91	0.3026
2	0.54	27	0.0915
3	0.81	8	0.0277
4	1.08	3	0.0084
5	1.35	1	0.0025
6	1.62	0	0.0008
7	1.89	0	0.0002
8	2.16	0	0.0001
9	2.43	0	0.0000
10	2.70	0	0.0000
15	4.05	0	0.0000
20	5.40	0	0.0000
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant: Benzene
Koc = 95.6 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0956 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 54 ug/L
Retardation Factor = 1.8843 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 0.27 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	25	0.4693
2	0.54	12	0.2202
3	0.81	6	0.1034
4	1.08	3	0.0485
5	1.35	1	0.0228
6	1.62	1	0.0107
7	1.89	0	0.0050
8	2.16	0	0.0024
9	2.43	0	0.0011
10	2.70	0	0.0005
15	4.05	0	0.0000
20	5.40	0	0.0000
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	1,2 DCA	
Koc =	28	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.028	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	24	ug/L
Retardation Factor =	1.259	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	0.27	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	5	0.2057
2	0.54	1	0.0423
3	0.81	0	0.0087
4	1.08	0	0.0018
5	1.35	0	0.0004
6	1.62	0	0.0001
7	1.89	0	0.0000
8	2.16	0	0.0000
9	2.43	0	0.0000
10	2.70	0	0.0000
15	4.05	0	0.0000
20	5.40	0	0.0000
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: 1,2 DCE
Koc = 4.5 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0045 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 120 ug/L
Retardation Factor = 1.0416 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 0.27 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	5	0.0400
2	0.54	0	0.0016
3	0.81	0	0.0001
4	1.08	0	0.0000
5	1.35	0	0.0000
6	1.62	0	0.0000
7	1.89	0	0.0000
8	2.16	0	0.0000
9	2.43	0	0.0000
10	2.70	0	0.0000
15	4.05	0	0.0000
20	5.40	0	0.0000
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: Ethylbenzene
Koc = 1100 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 1.1 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 2,400 ug/L
Retardation Factor = 11.175 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 **decimal percent**
Density = 1.85 **g/cm3**
Pore Volume Time = 0.27 **years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	2,185	0.9105
2	0.54	1,990	0.8290
3	0.81	1,812	0.7548
4	1.08	1,650	0.6873
5	1.35	1,502	0.6258
6	1.62	1,368	0.5698
7	1.89	1,245	0.5188
8	2.16	1,134	0.4724
9	2.43	1,032	0.4301
10	2.70	940	0.3916
15	4.05	588	0.2451
20	5.40	368	0.1534
30	8.10	144	0.0601

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	**Toluene**	
Koc =	300	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.3	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	11,000	ug/L
Retardation Factor =	3.775	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	**0.27**	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	8,086	0.7351
2	0.54	5,944	0.5404
3	0.81	4,369	0.3972
4	1.08	3,212	0.2920
5	1.35	2,361	0.2146
6	1.62	1,736	0.1578
7	1.89	1,276	0.1160
8	2.16	938	0.0853
9	2.43	689	0.0627
10	2.70	507	0.0461
15	4.05	109	0.0099
20	5.40	23	0.0021
30	8.10	1	0.0001

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	TCE	
Koc =	217	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.217	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	76	ug/L
Retardation Factor =	3.00725	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	0.27	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L	Proportion Remaining pvConc/oConc
1	0.27	51	0.6675
2	0.54	34	0.4455
3	0.81	23	0.2974
4	1.08	15	0.1985
5	1.35	10	0.1325
6	1.62	7	0.0884
7	1.89	4	0.0590
8	2.16	3	0.0394
9	2.43	2	0.0263
10	2.70	1	0.0176
15	4.05	0	0.0023
20	5.40	0	0.0003
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant	TCE	
Koc =	217	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.217	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	15	ug/L
Retardation Factor =	3.00725	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	**0.27**	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	10	0.6675
2	0.54	7	0.4455
3	0.81	4	0.2974
4	1.08	3	0.1985
5	1.35	2	0.1325
6	1.62	1	0.0884
7	1.89	1	0.0590
8	2.16	1	0.0394
9	2.43	0	0.0263
10	2.70	0	0.0176
15	4.05	0	0.0023
20	5.40	0	0.0003
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant:	Vinyl Chloride	
Koc =	19.4	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.0194	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	72	ug/L
Retardation Factor =	1.1795	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	0.27	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	11	0.1521
2	0.54	2	0.0231
3	0.81	0	0.0035
4	1.08	0	0.0005
5	1.35	0	0.0001
6	1.62	0	0.0000
7	1.89	0	0.0000
8	2.16	0	0.0000
9	2.43	0	0.0000
10	2.70	0	0.0000
15	4.05	0	0.0000
20	5.40	0	0.0000
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	Xylenes	
Koc =	240	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.24	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	18,000	ug/L
Retardation Factor =	3.22	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	0.27	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	0.27	12,410	0.6894
2	0.54	8,556	0.4753
3	0.81	5,899	0.3277
4	1.08	4,067	0.2259
5	1.35	2,804	0.1558
6	1.62	1,933	0.1074
7	1.89	1,333	0.0740
8	2.16	919	0.0510
9	2.43	633	0.0352
10	2.70	437	0.0243
15	4.05	68	0.0038
20	5.40	11	0.0006
30	8.10	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: 1,2 DCE
Koc = 4.5 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0045 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 120 ug/L
Retardation Factor = 1.0416 Note: R=1+(Kd*Density)/ne
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 3.7 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	3.70	5	0.0400
2	7.40	0	0.0016
3	11.10	0	0.0001
4	14.80	0	0.0000
5	18.50	0	0.0000
6	22.20	0	0.0000
7	25.90	0	0.0000
8	29.60	0	0.0000
9	33.30	0	0.0000
10	37.00	0	0.0000
15	55.50	0	0.0000
20	74.00	0	0.0000
30	111.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	TCE	
Koc =	217	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.217	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	15	ug/L
Retardation Factor =	3.0073	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	3.7	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	3.70	10	0.6675
2	7.40	7	0.4455
3	11.10	4	0.2974
4	14.80	3	0.1985
5	18.50	2	0.1325
6	22.20	1	0.0884
7	25.90	1	0.0590
8	29.60	1	0.0394
9	33.30	0	0.0263
10	37.00	0	0.0176
15	55.50	0	0.0023
20	74.00	0	0.0003
30	111.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant:	TCE	
Koc =	217	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.217	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	76	ug/L
Retardation Factor =	3.0073	**Note: R=1+(Kd*Density)/ne**
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	3.7	**years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	3.70	51	0.6675
2	7.40	34	0.4455
3	11.10	23	0.2974
4	14.80	15	0.1985
5	18.50	10	0.1325
6	22.20	7	0.0884
7	25.90	4	0.0590
8	29.60	3	0.0394
9	33.30	2	0.0263
10	37.00	1	0.0176
15	55.50	0	0.0023
20	74.00	0	0.0003
30	111.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant: Vinyl Chloride
Koc = 19.4 **mL/g(organic carbon partion coefficient for contaminant)**
foc = 0.001 **fractional organic carbon content in aquifer**
Kd = 0.0194 **mL/g(distribution coefficient for contaminant; Koc*foc)**
Initial GW Conc = 72 ug/L
Retardation Factor = 1.1795 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 **decimal percent**
Density = 1.85 **g/cm3**
Pore Volume Time = 3.7 **years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	**time (years)**	**pvConc (ug/L)**	**Proportion Remaining pvConc/oConc**
1	3.70	11	0.1521
2	7.40	2	0.0231
3	11.10	0	0.0035
4	14.80	0	0.0005
5	18.50	0	0.0001
6	22.20	0	0.0000
7	25.90	0	0.0000
8	29.60	0	0.0000
9	33.30	0	0.0000
10	37.00	0	0.0000
15	55.50	0	0.0000
20	74.00	0	0.0000
30	111.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Elec+ro Voice GL065601.FS.AE

Contaminant: Benzene
Koc = 95.6 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0956 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 54 ug/L
Retardation Factor = 1.8843 Note: R=1+(Kd*Density)/ne
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 8.1 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	25	0.4693
2	16.20	12	0.2202
3	24.30	6	0.1034
4	32.40	3	0.0485
5	40.50	1	0.0228
6	48.60	1	0.0107
7	56.70	0	0.0050
8	64.80	0	0.0024
9	72.90	0	0.0011
10	81.00	0	0.0005
15	121.50	0	0.0000
20	162.00	0	0.0000
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: 1,1 DCA
Koc = 46.9 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0469 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 300 ug/L
Retardation Factor = 1.4338 Note: R=1+(Kd*Density)/ne
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 8.1 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	91	0.3026
2	16.20	27	0.0915
3	24.30	8	0.0277
4	32.40	3	0.0084
5	40.50	1	0.0025
6	48.60	0	0.0008
7	56.70	0	0.0002
8	64.80	0	0.0001
9	72.90	0	0.0000
10	81.00	0	0.0000
15	121.50	0	0.0000
20	162.00	0	0.0000
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant:	1,2 DCA	
Koc =	28	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.028	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	24	ug/L
Retardation Factor =	1.259	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.1	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	5	0.2057
2	16.20	1	0.0423
3	24.30	0	0.0087
4	32.40	0	0.0018
5	40.50	0	0.0004
6	48.60	0	0.0001
7	56.70	0	0.0000
8	64.80	0	0.0000
9	72.90	0	0.0000
10	81.00	0	0.0000
15	121.50	0	0.0000
20	162.00	0	0.0000
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant: 1,2 DCE
Koc = 4.5 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.0045 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 120 ug/L
Retardation Factor = 1.0416 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 8.1 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	5	0.0400
2	16.20	0	0.0016
3	24.30	0	0.0001
4	32.40	0	0.0000
5	40.50	0	0.0000
6	48.60	0	0.0000
7	56.70	0	0.0000
8	64.80	0	0.0000
9	72.90	0	0.0000
10	81.00	0	0.0000
15	121.50	0	0.0000
20	162.00	0	0.0000
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.PS.AE

Contaminant: Ethylbenzene

Koc =	1100	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	1.1	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	2,400	ug/L
Retardation Factor =	11.175	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.1	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	2,185	0.9105
2	16.20	1,990	0.8290
3	24.30	1,812	0.7548
4	32.40	1,650	0.6873
5	40.50	1,502	0.6258
6	48.60	1,368	0.5698
7	56.70	1,245	0.5188
8	64.80	1,134	0.4724
9	72.90	1,032	0.4301
10	81.00	940	0.3916
15	121.50	588	0.2451
20	162.00	368	0.1534
30	243.00	144	0.0601

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	Toluene	
Koc =	300	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.3	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	11,000	ug/L
Retardation Factor =	3.775	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.1	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	8,086	0.7351
2	16.20	5,944	0.5404
3	24.30	4,369	0.3972
4	32.40	3,212	0.2920
5	40.50	2,361	0.2146
6	48.60	1,736	0.1578
7	56.70	1,276	0.1160
8	64.80	938	0.0853
9	72.90	689	0.0627
10	81.00	507	0.0461
15	121.50	109	0.0099
20	162.00	23	0.0021
30	243.00	1	0.0001

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: TCE
Koc = 217 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.217 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 15 ug/L
Retardation Factor = 3.0073 Note: R=1+(Kd*Density)/ne
ne = 0.2 decimal percent
Density = 1.85 g/cm3
Pore Volume Time = 8.1 years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	10	0.6675
2	16.20	7	0.4455
3	24.30	4	0.2974
4	32.40	3	0.1985
5	40.50	2	0.1325
6	48.60	1	0.0884
7	56.70	1	0.0590
8	64.80	1	0.0394
9	72.90	0	0.0263
10	81.00	0	0.0176
15	121.50	0	0.0023
20	162.00	0	0.0003
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant: TCE
Koc = 217 mL/g(organic carbon partion coefficient for contaminant)
foc = 0.001 fractional organic carbon content in aquifer
Kd = 0.217 mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc = 76 ug/L
Retardation Factor = 3.0073 **Note: R=1+(Kd*Density)/ne**
ne = 0.2 **decimal percent**
Density = 1.85 g/cm3
Pore Volume Time = 8.1 **years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	**time (years)**	**pvConc (ug/L)**	**Proportion Remaining pvConc/oConc**
1	8.10	51	0.6675
2	16.20	34	0.4455
3	24.30	23	0.2974
4	32.40	15	0.1985
5	40.50	10	0.1325
6	48.60	7	0.0884
7	56.70	4	0.0590
8	64.80	3	0.0394
9	72.90	2	0.0263
10	81.00	1	0.0176
15	121.50	0	0.0023
20	162.00	0	0.0003
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GLO65601.FS.AE

Contaminant: Vinyl Chloride

Koc =	19.4	mL/g(organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.0194	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	72	ug/L
Retardation Factor =	1.1795	**Note: R=1+(Kd*Density)/ne**
ne =	0.2	**decimal percent**
Density =	1.85	**g/cm3**
Pore Volume Time =	8.1	**years to remove one pore volume**

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	11	0.1521
2	16.20	2	0.0231
3	24.30	0	0.0035
4	32.40	0	0.0005
5	40.50	0	0.0001
6	48.60	0	0.0000
7	56.70	0	0.0000
8	64.80	0	0.0000
9	72.90	0	0.0000
10	81.00	0	0.0000
15	121.50	0	0.0000
20	162.00	0	0.0000
30	243.00	0	0.0000

CLEANUP TIME ESTIMATES FOR GROUNDWATER
Electro Voice GL065601.FS.AE

Contaminant:	Xylenes	
Koc =	240	mL/g(organic carbon partition coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.24	mL/g(distribution coefficient for contaminant; Koc*foc)
Initial GW Conc =	18,000	ug/L
Retardation Factor =	3.22	Note: R=1+(Kd*Density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.1	years to remove one pore volume

pvConc = oConc*exp(-ln(R/R-1))*npv
where:
pvConc = Concentration in groundwater after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

#Pore Vol.	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.10	12,410	0.6894
2	16.20	8,556	0.4753
3	24.30	5,899	0.3277
4	32.40	4,067	0.2259
5	40.50	2,804	0.1558
6	48.60	1,933	0.1074
7	56.70	1,333	0.0740
8	64.80	919	0.0510
9	72.90	633	0.0352
10	81.00	437	0.0243
15	121.50	68	0.0038
20	162.00	11	0.0006
30	243.00	0	0.0000

MEMORANDUM

CH2M HILL

TO: Elizabeth Reiner/U.S. EPA

COPIES: Al Sloan/CH2M HILL

FROM: Ken Shump/CH2M HILL

DATE: December 27, 1991

SUBJECT: Electro-Voice, Inc. Feasibility Study
PRP Comments

PROJECT: GLO65601.PS.MG

In our telephone conversation on December 12, you asked for a summary of CH2M HILL's responses to some of the issues raised in "Appendix B" attached to Electro-Voice's letter dated November 27, 1991. This memorandum focuses on offsite issues, because it is our understanding that this is the area of greatest concern.

Comments number 1 through 3 deal with onsite remediation, so these comments will not be discussed in this memorandum.

Comment 4 The point made by Electro-Voice about the capture zone width is valid. The confusion reflected in this comment was caused by an attempt to add a measure of conservatism to the relative remediation time estimates presented in the FS. It is expected that during the predesign phase, extraction wells would be positioned so the capture zone width would coincide with the width of the contaminant plume.

The reason for adding a measure of conservatism is to recognize that pore flushing caused by groundwater movement (either under pumping conditions or under natural flow conditions) is not 100 percent efficient. In other words, when a pore volume of groundwater is removed from the contaminated zone and replaced with "clean" groundwater, not all pore spaces are completely flushed. Because of the tortuous shape of pore spaces in a granular porous medium such as that at the Electro-Voice site, many dead-end pores exist that would not be flushed by advection (groundwater movement) Instead, contamination in dead-end pores would be removed by molecular diffusion into pores that are actively flushed by groundwater movement. It was assumed that 70 percent of the porosity in the aquifer would flushed by exchanging each pore volume.

Comment 4 (continued) In retrospect, a clearer way to present this factor would be to reduce the rate of groundwater removal (both in the pumping and non-pumping alternatives) by 30 percent, thereby reducing the efficiency of flushing to 70 percent rather than 100 percent. The pumping rate for the 5 extraction wells would be reduced from a total of 60 gallons per minute (gpm) to 0.7 *x* 60 gpm, or 42 gpm (equivalent to 2.95 million cubic feet/year). Using the value for hydraulic conductivity identified by Electro-Voice in its letter (620 gal/day/ft^2) and accounting for inefficiency in flushing pore spaces, the flushing rate for the non-pumping alternative would be reduced from 55,700 gallons per day (gal/day) to 0.7 *x* 55,700 gal/day, or 39,000 gal/day (equivalent to 1.9 million cubic feet/year).

Comment 5 This comment is rendered moot by the response to Comment 4.

Comment 6 This comment includes several topics, but its focus is on two hydraulic properties of the aquifer: hydraulic conductivity and hydraulic gradient.

Hydraulic conductivity, sometimes called permeability, is a measure of the ease with which groundwater moves through the aquifer. Hydraulic conductivity is an unusual property because it varies over a tremendously wide range in nature: more than nine orders of magnitude from a value of 10^{-4} gallons/day/ft^2 for massive clay to 10^5 gallons/day/ft^2 for clean gravel. In general, values for hydraulic conductivity that lie within the same order of magnitude are considered to be similar. Electro-Voice points out an apparent discrepancy in hydraulic conductivity values in the FS, because the FS used a value of 620 gallons/day/ft^2 for one alternative and 439 gallons/day/ft^2 for another. Different values were originally used to account for slightly different areas covered by the two alternatives being discussed.

As described in the RI Report, the range in measured hydraulic conductivity values at the site varied by a factor of almost 8: from 335 gallons/day/ft^2 to 2,550 gallons/day/ft^2. Viewed in this context, the two values used in the FS, which differ by a factor of about 1.4, should be considered to be essentially the same number.

Hydraulic gradient, which is the driving force that causes groundwater to flow, is estimated by dividing the difference in groundwater elevations in wells located along the same flow path by the distance between the wells. Hydraulic gradient can be viewed as analogous to the slope of a hillside. Rainfall runs off a steep hillside more quickly than a gentle hillside. Similarly, groundwater flows more quickly under the influence of a steeper gradient than a gentle

Comment 6 (continued) gradient. Just as the magnitude of the slope on a hillside varies from point to point, so does the magnitude of the hydraulic gradient. As pointed out by Electro-Voice, the choice of hydraulic gradient can be subjective and can vary significantly, depending on the choice of measuring points in the particular portion of the aquifer being considered.

Electro-Voice points out that, using the available data, it is possible to calculate steeper gradients from those presented in the FS, which have the effect of increasing the estimated rates of groundwater flow and pore volume flushing under natural conditions. It is also possible to calculate more gentle gradients from the available data, which would have the effect of decreasing the estimated rates of groundwater flow and pore volume flushing. CH2M HILL believes that the values of hydraulic gradient used in the FS are reasonable for comparison purposes.

Comment 7 Insufficient information is provided regarding the actual equations and assumptions used by Electro-Voice to evaluate the validity of the calculations described in Comment 7. The procedures used in the FS are consistent with procedures commonly used elsewhere to estimate groundwater remediation times for comparison purposes.

A fundamental problem with using the hydraulic gradient values provided in the RI Report is that it is not known how the gradient varies over time. An implicit assumption of the non-pumping alternative is that the hydraulic gradient values calculated from RI data are reasonable estimates of long-term hydraulic gradients. Hydraulic gradients vary over time because of the effects of seasonal variations in pumping, recharge, and stream flow. One advantage of installing extraction wells is that wells allow the hydraulic gradients to be controlled to some degree by varying pumping rates. Under the non-pumping alternative, nothing can be done to influence hydraulic gradients. If the hydraulic gradient estimates currently available turn out to be higher than long-term average gradients, the actual pore volume flushing time could be longer than estimated by Electro-Voice. Conversely, if currently estimated gradients turn out to be lower than long-term average gradients, actual pore volume flushing times could be shorter.

Comment 8 The groundwater remediation time estimates presented in the FS were recalculated using the efficiency factor described above (70 percent) and the value of hydraulic conductivity preferred by Electro-Voice (620 gallons/day/ft^2). As discussed in the response to Comment 6, the estimates presented in the FS for hydraulic gradient are considered reasonable and were not changed. The

Comment 8 (continued) revised estimates of groundwater remediation times were made on the basis of the highest trichloroethene (TCE) concentrations measured in 1990 (76 μg/L) and 1991 (41 μg/L). Two alternatives were considered: five extraction wells pumping 60 gpm, and natural flushing with no offsite pumping. Results of these calculations are presented below:

Estimated Time to Reach Groundwater Goal of 3 μg/L of TCE

Alternative	Initial TCE Concentration	
	76 μg/L	41 μg/L
No Offsite Pumping	66 years	53 years
Offsite Pumping	42 years	35 years

Refer to the attached sheets for additional details about the methods and assumptions used for these estimates.

Accurate prediction of groundwater contaminant concentrations versus time requires simulation of complex physical and geochemical processes. These processes include contaminant partitioning between groundwater and the aquifer skeleton and other sorption sites such as particulate organic carbon and metal hydroxides; mixing processes such as dispersion and diffusion; dilution by recharge; chemical reactions such as precipitation, volatilization, hydrolysis, and chelation; cosolvent/common ion effects; and biological degradation. The relatively simple calculations used to make these estimates required numerous assumptions to make the problem tractable. The usefulness of this method is its ability to estimate relative contaminant behavior under different remediation alternatives.

Recommendations

The exchange of widely differing views on groundwater remediation at the Electro-Voice site is partly caused by the limited amount of site-specific data, which requires tenuous assumptions to be made about fundamental physical properties at the site. Additional work is recommended to resolve some of these differences.

Groundwater Sampling and Analysis

The available data on TCE indicates that concentrations are variable over time. It is not clear if the decrease in TCE concentrations observed between 1990 and 1991 is evidence of a trend or is evidence of random variation caused by seasonality or sampling/analysis variability. It is recommended that groundwater quality samples be collected and analyzed quarterly for a period of two years, using consistent procedures, to document whether any concentration trend is evident.

Groundwater Level Measurements

The principal variable governing groundwater remediation rates under the non-pumping alternative is hydraulic gradient. Currently, little is known about seasonal variability in hydraulic gradient. It is recommended that monthly groundwater level measurements and stream stage measurements be made onsite and offsite to determine a more reliable and defensible estimate of groundwater remediation under the non-pumping alternative. Measurements made over a period of two years, to coincide with the period of groundwater quality sampling, should be sufficient.

Aquifer Test

The available data on hydraulic conductivity at the site is insufficient for design purposes and is suspect because the test method used in the past (slug testing) is most appropriate for estimating the hydraulic conductivity in the vicinity of monitoring wells completed in aquifers with fairly low permeability. A constant rate pumping test is more appropriate in moderate to highly permeable aquifers where a more areally-averaged value of hydraulic conductivity is needed. Conducting a pumping test will allow actual aquifer response to pumping stress to be measured, which will allow the pumping rates for extraction wells to be more reliably estimated. A pumping test will also provide a more reliable estimate of hydraulic conductivity to be calculated for use in estimating groundwater remediation times under pumping and non-pumping conditions.

Organic Carbon Content

Conducting an aquifer test will require installation of a test well and possibly two or more temporary piezometers (observation wells). It is recommended that soil sampling and analysis be conducted while drilling these wells so the organic carbon content of the aquifer material can be estimated more accurately. This will allow the groundwater remediation time estimates to better reflect actual site conditions.

Electro Voice Groundwater Cleanup Time Estimate
GLO65601.PS.MG

Pumping Alternative: 5 wells pumping at 12 gpm each = 60 gpm total. Assume pumping is 70% efficient at flushing pores, so the effective pumping rate is 42 gpm, or 2.95 million cubic ft/yr.
Assuming the volume of contaminated groundwater that must be flushed is 15.5 million cubic feet, the time required to flush one pore volume is 5.3 years.

Contaminant: Trichloroethene

Koc =	217	mL/g (organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.22	mL/g (distribution coefficient for contaminant)
Initial GW Conc =	76	ug/L
Retardation Factor =	3.04	Note: R=1+(Kd*density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	5.3	years to remove one pore volume

pvConc = oConc*exp{(-ln(R/R-1))*npv}
where:
pvConc = Concentration in groundwater remaining after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

Number of Pore Volumes	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	5.3	51	0.67
2	11	34	0.45
3	16	23	0.30
4	21	15	0.20
5	27	10	0.14
6	32	6.9	0.091
7	37	4.7	0.061
8	42	3.1	0.041
9	48	2.1	0.028
10	53	1.4	0.019

EVTCE1.WR1

Electro Voice Groundwater Cleanup Time Estimate
GLO65601.PS.MG

Non-Pumping Alternative: Natural flux of groundwater through the zone to be remediated is estimated to be 55,700 gal/day. Assuming that groundwater movement is 70% efficient at flushing pores, the effective flushing rate is 39,000 gal/day, or 1.9 million cubic ft/yr. Assuming that the volume of contaminated groundwater that must be flushed is 15.5 million cubic feet, the time required to flush one pore volume is 8.2 years.

Contaminant: Trichloroethene

Koc =	217	mL/g (organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.22	mL/g (distribution coefficient for contaminant)
Initial GW Conc =	76	ug/L
Retardation Factor =	3.04	Note: R=1+(Kd*density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.2	years to remove one pore volume

pvConc = oConc*exp{(-ln(R/R-1))*npv}
where:
pvConc = Concentration in groundwater remaining after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

Number of Pore Volumes	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.2	51	0.67
2	16	34	0.45
3	25	23	0.30
4	33	15	0.20
5	41	10	0.14
6	49	6.9	0.091
7	57	4.7	0.061
8	66	3.1	0.041
9	74	2.1	0.028
10	82	1.4	0.019
11	90	0.9	0.012

EVTCE1.WR1

Electro Voice Groundwater Cleanup Time Estimate
GLO65601.PS.MG

Pumping Alternative: 5 wells pumping at 12 gpm each = 60 gpm total. Assume pumping is 70% efficient at flushing pores, so the effective pumping rate is 42 gpm, or 2.95 million cubic ft/yr.
Assuming the volume of contaminated groundwater that must be flushed is 15.5 million cubic feet, the time required to flush one pore volume is 5.3 years.

Contaminant: Trichloroethene

Koc =	217	mL/g (organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.22	mL/g (distribution coefficient for contaminant)
Initial GW Conc =	41	ug/L
Retardation Factor =	3.04	Note: R=1+(Kd*density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	5.3	years to remove one pore volume

pvConc = oConc*exp{(-ln(R/R-1))*npv}
where:
pvConc = Concentration in groundwater remaining after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

Number of Pore Volumes	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	5.3	28	0.67
2	11	18	0.45
3	16	12	0.30
4	21	8	0.20
5	27	6	0.14
6	32	3.7	0.091
7	37	2.5	0.061
8	42	1.7	0.041
9	48	1.1	0.028
10	53	0.8	0.019

EVTCE1.WR1

Electro Voice Groundwater Cleanup Time Estimate
GLO65601.PS.MG

Non-Pumping Alternative: Natural flux of groundwater through the zone to be remediated is estimated to be 55,700 gal/day. Assuming that groundwater movement is 70% efficient at flushing pores, the effective flushing rate is 39,000 gal/day, or 1.9 million cubic ft/yr. Assuming that the volume of contaminated groundwater that must be flushed is 15.5 million cubic feet, the time required to flush one pore volume is 8.2 years.

Contaminant: Trichloroethene		
Koc =	217	mL/g (organic carbon partion coefficient for contaminant)
foc =	0.001	fractional organic carbon content in aquifer
Kd =	0.22	mL/g (distribution coefficient for contaminant)
Initial GW Conc =	41	ug/L
Retardation Factor =	3.04	Note: R=1+(Kd*density)/ne
ne =	0.2	decimal percent
Density =	1.85	g/cm3
Pore Volume Time =	8.2	years to remove one pore volume

pvConc = oConc*exp{(-ln(R/R-1))*npv}
where:
pvConc = Concentration in groundwater remaining after n pore volumes have been removed
oConc = Original Concentration in groundwater
R = retardation factor
npv = number of pore volumes removed

Number of Pore Volumes	time (years)	pvConc (ug/L)	Proportion Remaining pvConc/oConc
1	8.2	28	0.67
2	16	18	0.45
3	25	12	0.30
4	33	8	0.20
5	41	6	0.14
6	49	3.7	0.091
7	57	2.5	0.061
8	66	1.7	0.041
9	74	1.1	0.028
10	82	0.8	0.019

EVTCE4.WR1

ATTACHMENT 4

Possible Considerations for a Monitoring Plan for Monitored Natural Attenuation

3.2

POSSIBLE CONSIDERATIONS FOR MONITORED NATURAL ATTENUATION MONITORING PLAN

Based on the results of Electro-Voice's 1998 off-property groundwater investigation and groundwater monitoring from 1993 to 1998, monitoring for natural attenuation of the off-property groundwater would likely be semiannual. However, some wells, such as wells at the edges of the plume, may need to be monitored on a more frequent basis, and other wells may be monitored less frequently. Additionally, the TCE plume is inferred to discharge to McCoy Creek in the area of MC-7. However, this discharge cannot be verified since there is not a monitoring well on the south/east side of the creek. A monitoring well will be required at this location as part of the monitored natural attenuation remedial plan. In addition, the remedy also includes the installation of 1 to 3 additional monitoring wells, if required.

Table 5-1 presents a possible monitoring well network for monitored natural attenuation and the rationale for selection. The final monitoring program for natural attenuation will be developed in the Statement of Work or during the Remedial Design.

Table 5-1
Proposed Monitoring Network
Off-Property Groundwater Evaluation
Electro-Voice Site

Monitoring Well ID	Sample	Rationale
MW-1	N	Abandoned well
MW-2	N	No TCE/cis-1,2-DCE detected
MW-3	N	No TCE/cis-1,2-DCE detected
MW-4	N	Abandoned well
MW-5 (B)	Y	Background well
MW-6 (B)	Y	Background well
MW-7 (B)	Y	Background well
MW-8	Y	Immediately downgradient well
MW-9s	Y	Immediately downgradient well
MW-9d	Y	Immediately downgradient well
MW-10	N	Abandoned well
MW-11 (B)	Y	Background well
MW-12	N	No TCE/cis-1,2-DCE detected
MW-13 (B)	Y	Background well
MW-14	Y	Immediately downgradient well
MW-15	Y	Plume boundary well
MW-16	Y	Immediately downgradient well
MW-17	Y	Immediately downgradient well
MW-18s	Y	Plume well
MW-18d	Y	Plume well
MW-19s	Y	Plume boundary well
MW-19d	N	Screened below potential contamination
MW-20	Y	Plume well
MW-21	Y	Plume boundary well
MW-22	Y	Plume well
MW-23	Y	Plume well
MW-24	Y	Plume well
MW-25	Y	Plume boundary well
MW-26s (MC)	Y	Plume well
MW-26d (MC)	Y	Plume well
MW-27s (MC)	Y	Plume boundary well
MW-27d (MC)	N	Non-impacted well
MW-28 (MC)	Y	Plume boundary well
MW-29	Y	Plume boundary well
MW-30 (MC)	Y	Plume well
MW-31	N	Located away from the impacted area
MW-32	N	Located away from the impacted area
MW-33 (MC)	Y	Plume boundary well
MW-34	N	Located away from the impacted area
MW-35 (MC)	Y	Plume boundary well
MW-36	N	Located away from the impacted area
MW-37	Y	Plume boundary well
MW-38s	N	Located away from the impacted area
MW-38d	N	Located away from the impacted area

(B) - Background well
(MC) - McCoy Creek well

APPENDIX A

Responsiveness Summary

RESPONSIVENESS SUMMARY

U.S. EPA met the public participation requirements of CERCLA sections 113(k)(2)(i-v) and 117 of CERCLA during the remedy selection process. These sections require U.S. EPA to respond "...to each of the significant comments, criticisms, and new data submitted in written or oral presentations" on its proposed plan for remedial action. This Responsiveness Summary addresses the concerns expressed by the public, the potentially responsible party (PRP), and governmental bodies in written and oral comments received by U.S. EPA during the public comment period for the proposed final remedy for the Electro-Voice site.

BACKGROUND

Information Repository

U.S. EPA established an information repository for site-related documents and an administrative record file for the Electro-Voice site at the Buchanan Public Library, 117 West Front Street, Buchanan, Michigan. U.S. EPA also maintains an administrative record file at the U.S. EPA Region 5 Superfund Division Records Center in Chicago, Illinois. These repositories contain all major site documents including the 1990 remedial investigation (RI) report and risk assessment, the 1991 feasibility study (FS) report, the 1992 record of decision (ROD) for operable unit 1 (OU1) and the 1993, 1995 and 1996 explanations of significant differences (ESDs). In July 1999 U.S. EPA added the June 1999 Technical Memorandum for the Evaluation of Off-Property Groundwater and U.S. EPA's proposed cleanup plan for the off-property groundwater to the repositories.

Public Notices and Fact Sheets

U.S. EPA announced its proposed cleanup plan for the off-property groundwater in advertisements published in the Niles Star on June 25, 1999 and in the Berrien County Record on June 30, 1999. The advertisements included information about U.S. EPA's proposed plan, the other alternatives that U.S. EPA considered, the upcoming public meeting and the public comment period. On July 3, 1999, U.S. EPA mailed several hundred copies of the proposed plan to local residents and other interested parties. U.S. EPA accepted public comments on its proposed plan from July 9 to August 8 1999. U.S. EPA did not receive any requests to extend the public comment period.

Public Meeting

On July 14, 1999, U.S. EPA held a public meeting in Buchanan. At the meeting, U.S. EPA presented its proposed plan for the off-property groundwater to the community and answered questions about the site and the other cleanup alternatives that U.S. EPA considered. U.S. EPA also used this meeting to solicit a wider cross-section of community input on the current and potential future uses of groundwater in the area. The meeting was attended by approximately 12 people, including three Buchanan city commissioners, staff from the state representative's office, two newspaper reporters, a local television news reporter, two residents, an Electro-Voice employee and two of Mark IV's engineering consultants.

Public Comments

U.S. EPA received two oral comments and one written comment during the comment period. One comment was from a resident who complained about the poor condition Electro-Voice left her grandson's property in after constructing the clay cap over the lagoons, but did not have any comments on the proposed remedy for off-property groundwater. The second comment was from a Buchanan city commissioner who thought that the longer cleanup time frame for the monitored natural attenuation alternative was unreasonable; was concerned about impacts to McCoy Creek and the St. Joseph River; and expressed his preference for the groundwater pump and treat alternative. The last comment was from Mark IV's engineering consultants who supported U.S. EPA's proposed plan and commented on the calculation of the cleanup time frames. U.S. EPA did not receive any other comments on the proposed plan. The public comments and U.S. EPA's response to each comment are summarized below.

SUMMARY OF PUBLIC COMMENTS

Stakeholder Issues

Comment 1: A Buchanan city commissioner who was also mayor pro tem expressed his preference for Alternative 3 - Groundwater Pump and Treat. The city commissioner states that letting the contaminated groundwater filter into the creek will pose a risk to McCoy Creek, which is a major trout stream in the area. The commissioner is also concerned that the contamination will pollute the St. Joseph River and Lake Michigan.

The commissioner refers to the section of U.S. EPA's proposed plan that states:

> *The actual or threatened release of chemicals in the off-property groundwater, if not addressed by U.S. EPA's recommended cleanup plan or another active cleanup plan, may pose a current or potential threat to public health, welfare, or the environment*;

and says that this indicates that U.S. EPA itself is skeptical of its proposal.

The commissioner suggests that of the nine evaluation criteria, the only two that the monitored natural attenuation alternative meets are implementability and cost. The commissioner also believes that Electro-Voice should pay for a groundwater pump and treat system since they are responsible for the pollution. The commissioner concludes by questioning what will happen if natural attenuation takes longer than 65 years, especially since most of the parties involved in the cleanup will be dead by then.

U.S. EPA Response to Comment 1: *U.S. EPA acknowledges the commissioner's preference for a groundwater pump and treat system. However, one of the reasons U.S. EPA is selecting Alternative 2 - Monitored Natural Attenuation is because the off-property groundwater* *contamination does not pose any current risks to the plants and animals in McCoy Creek or to the people who fish in the creek. The main contaminants in the groundwater are chemicals called trichloroethene (TCE) and vinyl chloride. However, neither of these contaminants were detected in the off-property groundwater above Michigan's allowable levels for groundwater that empties into rivers and creeks.*

For example, in 1998, TCE was detected in the off-property groundwater at a maximum concentration of 26 parts per billion (ppb). This concentration is well below Michigan's allowable level of 200 ppb for groundwater that empties into rivers and creeks. This means that even though the contaminated groundwater empties into the creek, the creek will still be safe for humans, plants and animals. Similarly, the maximum concentration of vinyl chloride detected in the off-property groundwater in 1998 was 7 ppb. This concentration is also below Michigan's allowable level of 15 ppb. The monitoring that will be conducted as part of the natural attenuation remedy will ensure that the concentrations of these chemicals remain below Michigan standards as the groundwater empties into the creek. If the chemical concentrations exceed the standards and pose a threat to McCoy Creek, appropriate contingency actions will be implemented and U.S. EPA will reconsider its remedy decision.

Three metals - chromium, copper and zinc, were detected above background levels in one or two groundwater monitoring wells near the site. The concentrations of these chemicals are above Michigan's allowable levels for groundwater that empties into rivers and creeks. However, these chemicals are about ½ mile from McCoy Creek and are not expected to move with the groundwater and empty into the creek. Near the creek, the concentrations of these chemicals are below background. For these reasons, U.S. EPA believes that it is more appropriate to monitor the metals instead of actively remediating the metals. Contingency actions would also be implemented to ensure that if these metals do move, they will not empty into the creek at levels that could harm the creek or the people who fish in the creek.

As the commissioner pointed out, there is a fishing advisory for the St. Joseph River. However, this fishing advisory is because the St. Joseph River is contaminated with chemicals called polychlorinated biphenyls. These chemicals are not the same chemicals that are in the off-property groundwater and are not from Electro-Voice.

U.S. EPA does not believe that its statement in the proposed plan indicates that U.S. EPA is skeptical of its proposal. On the contrary, U.S. EPA believes that this statement provides U.S. EPA with the basis for cleaning up the off-property groundwater, and indicates that U.S. EPA's proposed alternative, or another active cleanup plan (but not the no further action alternative) is needed to address the risks posed by the off-property groundwater.

Concerning the alternatives evaluation and U.S. EPA's nine evaluation criteria, U.S. EPA cannot select a remedy that does not meet the first two evaluation criteria: overall protection of human health and the environment, and compliance with state and federal laws. The monitored natural attenuation alternative and the groundwater pump and treat alternative both *met these criteria. However, U.S. EPA also believes that the monitored natural attenuation alternative provides the best balance of trade-offs in terms of the remaining evaluation criteria.*

In its proposed plan, U.S. EPA indicated that the pump and treat alternative would clean up the groundwater in about ½ as much time as it would take the groundwater to clean up naturally. As discussed in Section 13 of this ROD, Documentation of Significant Changes in the Selected Remedy from the Proposed Plan, the cleanup time frames presented in U.S. EPA's proposed plan were incorrect. The actual cleanup time frames are approximately 53 to 66 years for monitored natural attenuation and 35 to 42 years for groundwater pump and treat. The groundwater cleanup will take approximately 18 to 24 more years with monitored natural attenuation than it would with groundwater pump and treat.

However, U.S. EPA believes that a cleanup time frame of approximately 53 to 66 years for monitored natural attenuation is reasonable for this site. This is because U.S. EPA does not expect the contamination to migrate significantly beyond its present boundaries, and because U.S. EPA does not expect that anyone will use the off-property groundwater as a source of drinking water in the foreseeable future. All residents except one are connected to the city water supply, and the off-property groundwater contaminants are not likely to impact the city wells or any of the private wells in the area. The City of Buchanan also has a local ordinance which prevents people from installing drinking water wells in areas designated by state or federal agencies as contaminated.

Additional information about U.S. EPA's detailed analysis of the alternatives is in Section 10 of this ROD, Comparative Analysis of Alternatives. Also, while U.S. EPA recognizes that the commissioner would like Electro-Voice to pay for a groundwater pump and treat system since Electro-Voice caused the pollution, the law requires U.S. EPA to select cleanup remedies based on its evaluation of the benefits and the cost-effectiveness of the different cleanup alternatives. U.S. EPA cannot not select cleanup remedies for a site based on a responsible party's liability or their ability to pay.

Finally, although the specific individuals involved in the site cleanup are not likely to be involved in the project for the duration of the off-property groundwater cleanup, U.S. EPA and the Michigan Department of Environmental Quality, or other similar government agencies, will continue to monitor the off-property groundwater cleanup and assign other individuals to the project as necessary. Also, if the long-term groundwater monitoring indicates that the concentrations of TCE or vinyl chloride are not decreasing at a rate that will return the aquifer to drinking water levels in approximately 53 to 66 years, or that the decreases in chemical concentrations differ significantly from the modeling predictions, U.S. EPA will reconsider the cleanup remedy for the off-property groundwater.

<u>Comment 2</u>: Mark IV's (the responsible party for the site) engineering consultant submitted a comment supporting the selection of Alternative 2 - Monitored Natural Attenuation as the final remedy for off-property groundwater.

U.S. EPA Response to Comment 2: *U.S. EPA acknowledges the engineering consultant's support for Alternative 2.*

Technical and Legal Issues

Comment 1: During the public meeting, a local resident complained about the poor condition Electro-Voice left her grandson's property in after they constructed the clay cap over the lagoons. According to the resident, Electro-Voice left brush and trash on her grandson's property. The resident also complained that Electro-Voice left a big hole in the area where water collects and which provides a breeding ground for mosquitos.

U.S. EPA Response to Comment 1: *U.S. EPA inspected the area the resident was concerned about after the public meeting. During the inspection, U.S. EPA noted some brush in the wooded slopes around the area. However, this area appears to be naturally wooded and the amount of brush did not seem unusual. U.S. EPA also noted a large sheet of heavy plastic covered by a large pile of soil cuttings near MW-16. These cuttings are not contaminated and were left over from Electro-Voice's 1998 off-property groundwater investigation. U.S. EPA did not notice any other trash in this area.*

U.S. EPA contacted Mark IV's (the responsible party's) engineering consultant about the soil cuttings. The consultant said that they will spread the uncontaminated cuttings over Electro-Voice's property in the next few months. This method of disposal is acceptable since the soil is not contaminated.

Concerning the brush, U.S. EPA's reports from the lagoon construction indicate that during the construction, Electro-Voice's contractor took most of the trees and branches off of the site. The contractor then excavated any remaining branches and wood chips with the contaminated soil and placed them under the lagoon cap. U.S. EPA confirmed this with the engineering consultant in charge of the lagoon cleanup. However, in order to fully respond to the resident's concern, U.S. EPA contacted the resident and made arrangements to meet her at the site in October 1999 so that the resident could point out her specific concerns. Mark IV's engineering consultants also agreed to meet U.S. EPA and the resident at the site and make arrangements to dispose of any brush or trash that was left behind after the construction.

Concerning the ponded area, U.S. EPA's reports from the lagoon construction and blueprint drawings show that the area of ponded water noted by the resident was purposely constructed during the lagoon cleanup to catch any rainwater running off the newly constructed, less-permeable clay cap. This water collects in the pond and seeps into the groundwater where it recharges the water table. The ponded area appears to be constructed on property to the south and east of the resident's grandson's property. Much of the pond appears to be in the right-of-way for Berrien Street. Although mosquitos can be annoying, the pond serves a useful purpose in capturing rainwater from the less-permeable capped area and recharging the water table.

Comment 2: Mark IV's (the responsible party's) engineering consultant commented that the difference in the cleanup times between the monitored natural attenuation alternative and the groundwater pump and treat alternative presented in the 1991 FS and U.S. EPA's June 1999 proposed plan does not reflect probable relative differences. According to the consultant, the relative difference between the two alternatives should be much less. This was indicated in previous comments Electro-Voice submitted to U.S. EPA during the 1991 public comment period. The consultant notes that U.S. EPA previously recognized these inconsistencies in estimating the cleanup time frames on pages 35 and 36 of U.S. EPA's Responsiveness Summary in the June 1992 ROD. U.S. EPA's recalculated cleanup time frames are 53 to 66 years for natural attenuation and 35 to 42 years for groundwater pump and treat. These revised calculations show that the cleanup time frames for the two alternatives vary by a factor of 1.5, instead of a factor of approximately 2.2 presented in U.S. EPA's June 1999 proposed plan.

The consultant argues that U.S. EPA's analysis and calculations of the cleanup time frames in the 1991 FS and the 1992 Responsiveness Summary do not employ consistent methods between the two alternatives; although U.S. EPA's revised calculations are more consistent than the calculations in the 1991 FS calculations. The consultant recognizes that there are many unknown variables to be considered when calculating cleanup times, and that cleanup time frames are calculated using basic assumptions. The consultant states that these assumptions can be debated with no clear resolution because of the fact that actual hydrogeological conditions and attenuation processes are complex. However, the consultant notes that these simplified assumptions and methods need to be consistent among the cleanup alternatives being considered to provide a more realistic basis for comparing relative differences in cleanup time frames.

The consultant states that he is emphasizing this point because the relative difference in cleanup times for the natural attenuation and groundwater pump and treat alternatives should be closer to a factor of 1.1 rather than 1.5 or 2.2. The consultant believes this is intuitive and is shown in previous modeling results. The consultant believes that this is because the groundwater pump and treat alternative considered in the 1991 FS consists of a line of purge wells close to and parallel with McCoy Creek. These extraction wells would intercept groundwater flow before it enters McCoy Creek without pulling water back from the creek. As a result, the extraction wells would be capturing groundwater that naturally flows into McCoy Creek. Since the impact from the groundwater pump and treat system on the hydraulic conditions of the aquifer over the entire groundwater plume is minimal, only very localized groundwater drawdown and hydraulic gradient changes would occur close to the extraction wells. Therefore, the overall plume pore volume exchange rate and/or velocity of groundwater would change very little

The consultant indicates that consistent modeling between the monitored natural attenuation alternative and the groundwater pump and treat alternative would show this to be true. This smaller relative difference in the cleanup time frames between the alternatives further supports

U.S. EPA's proposed plan for monitored natural attenuation, since there is actually no significant difference in the time frames.

U.S. EPA's Response to Comment 2: *U.S. EPA acknowledges that the cleanup time frames it presented its June 1999 proposed plan were inadvertently taken from the original 1991 FS. U.S. EPA subsequently revised the description of the alternatives and the corresponding discussions in this ROD to provide the corrected cleanup time frames for the monitored natural attenuation alternative and the groundwater pump and treat alternative. U.S. EPA's recalculated cleanup time frames incorporate several changes Electro-Voice's consultants proposed during the 1991 public comment period. These changes included revised values for hydraulic conductivity and percent efficiency factor.*

U.S. EPA presented its revised estimates of the cleanup time frames for groundwater in its Responsiveness Summary in the 1992 ROD. These revised estimates were calculated using the highest trichloroethene (TCE) concentrations measured in 1990 (76 ppb) and 1991 (41 ppb). U.S. EPA calculated these clean up time frames using the procedure described in the 1991 FS. Two alternatives were considered: five extraction wells pumping 60 gpm, and natural flushing with no offsite pumping. The results of U.S. EPA's calculations were:

Alternative	Initial TCE Concentration	
	41 ppb	76 ppb
Natural Attenuation	53 years	66 years
Groundwater Pump and Treat	35 years	42 years

U.S. EPA estimates the difference in cleanup time frames between natural attenuation and groundwater pump and treat to be 18 years, with the cleanup time frame associated with natural attenuation approximately 1.5 times longer than that for groundwater pump and treat. However, because the parameter values used to predict future concentration trends vary over a wide range, and any prediction requires using a number of simplifying assumptions, cleanup time frames that vary by a factor of 1.5, 1.1, or even 2.2 are essentially the same number.

It should be noted that the consultant's comments that indicate that the two alternatives would have similar cleanup time frames because the extraction wells would be placed close to McCoy Creek are only valid if the rate of groundwater removed from the zone of contamination by the extraction wells exactly matched the rate of water flux that discharges naturally to McCoy Creek. Under the groundwater pump and treat alternative, extraction wells would be installed and operated in a manner that would enhance water movement (i.e., flushing) through the plume, without directly withdrawing water from McCoy Creek. Because groundwater movement through the zone of contamination is greater with the pump and treat alternative than with the *natural attenuation alternative, the rate of cleanup is expected to be somewhat faster and the time to reach cleanup goals somewhat less.*

Concerning the consultant's statement that "the methods employed [for clean up time estimation] are not consistent between the two alternatives," the commenter did not provide specific reference to which methods were inconsistent. Therefore, U.S. EPA has included the consultant's original comment from 1991 and U.S. EPA's response in the 1992 Responsiveness Summary:

> Consultant's Comment from the 1991 Public Comment Period: The methods used to calculate pore volume exchange time for the pumping and non-pumping [natural attenuation] alternatives are not consistent. An alternate and more reliable and consistent method is to determine the velocity of ground water under pumping and non pumping conditions.
>
> U.S. EPA's Response in the 1992 Responsiveness Summary: *In any water budget analysis, mass must be conserved. For this case, the water pumped by the extraction wells must be supplied by the aquifer lying within the capture zone of the extraction wells. The total discharge from the extraction wells therefore would equal the total flux of groundwater through the capture zone. A volumetric calculation comparing the volume of aquifer flushed by the extraction wells and the discharge rate from the extraction wells provides a reliable estimate of the pore volume flushing time in the contaminated zone. The authors of the reference cited by the commenter in additional information submitted after the end of the public comment period (Javendel, I., and C.F. Change, Capture-Zone Type Curves, A Tool for Aquifer Cleanup, Groundwater, v. 234, n. 5, pp. 616-625) use the same method of calculating pore volume flushing times on a volumetric basis as U.S. EPA did in the FS [and subsequently used for revised estimates in the 1992 Responsiveness Summary].*
>
> *A fundamental problem with using the hydraulic gradient values [and resultant groundwater velocities] provided in the Remedial Investigation (RI) Report is that it is not known how the gradient varies over time. An implicit assumption of the non-pumping [natural attenuation] alternative is that the hydraulic gradient values calculated from RI data are reasonable estimates of long-term hydraulic gradients. Hydraulic gradients vary over time because of the effects of seasonal variations in pumping, recharge, and stream flow. One advantage of installing extraction wells is that wells allow the hydraulic gradients to be controlled to some degree by varying pumping rates. Under the non-pumping alternative, nothing can be done to influence hydraulic gradients. If long-term average hydraulic gradients turn out to be gentler than currently estimated gradients, the actual pore volume flushing time could be longer than estimated by the*

commenter. Conversely, if long term average gradients turn out to be steeper than current estimates, actual pore volume flushing times could be shorter.

APPENDIX B

State Letter of Concurrence

(Pending)

APPENDIX C

Administrative Record File

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ELECTRO-VOICE
BUCHANAN, MICHIGAN

FICHE/FRAME	PAGES	DATE	TITLE	AUTHOR	RECIPIENT	DOCUMENT TYPE	DOCNUMBER
	2	80/10/09	Letter re: Media reporting on Industrial Surface Impoundements allegedly contaminating some underground sources of drinking water	D. Bryson, USEPA	Electro Voice	Correspondence	1
	1	80/10/17	Letter re: October 9, 1980 Request for Information	R. Graham, Electro Voice	USEPA	Correspondence	2
	6	87/06/15	Letter re: General Notice that USEPA has documented the release or threatened release of hazardous substances, polluntants and contaminants at the Electrovoice site	B. Constantelos, USEPA	Electro Voice	Correspondence	3
	6	87/08/04	Letter re: General Notice letter to Clark Equipment Co.	Basil Constantelos, USEPA	Clark Equipment Corp.	Correspondence	4
	1	87/08/11	Letter re: Response from Clark Equipment Co. regarding General Notice Letter	Donald Commons, Clark Equipment Co.	Lisa Smith, USEPA	Correspondence	5
	12	87/08/28	Letter re: General Notice Response to USEPA's letter dated June 15, 1987 concerning Electro Voice	D. Calverley	P. Miller, USEPA	Correspondence	6
	12	90/06/20	Letter re: Review comments for the Alternatives Array (AA) and the Applicable or Relevant and Appropriate Requirements	Elizabeth Reiner, USEPA	Ron Graham, Electro-Voice	Correspondence	7

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			(ARARs)				
	2	90/10/11	Letter re: The identification of additional ARARs	Elizabeth Reiner, USEPA	Ron Graham, Electro-Voice	Correspondence	8
	3	90/11/15	Letter re: Electro-Voice Final Remedial Investigation Report approval with reservations	Elizabeth Reiner, USEPA	Ron Graham, Electro-Voice	Correspondence	9
	7	90/11/15	Letter re: Disapproval of the Draft Feasibility Study Report Administrative Order by Concent, No.V-W-87-C-023	Elizabeth Reiner, USEPA	Ron Graham, Electro-Voice	Correspondence	10
	62	87/10/15	Administrative Order on Consent in the matter of the Electro-Voice Remedial Investigation and Feasibility Study with cover letter	Peter Miller, USEPA	David Calverley	Pleading Order	11
	61	87/10/00	Work Plan Electro-Voice Site Remedial Investigation Feasiblity Study	Warzyn Engineering	MDNR	Report/Studies	12
	290	88/04/00	Electro-Voice Remedial Investigation Feasibility Study Work Plans	Fishbeck, Thompson, Carr & Huber, Inc.		Report/Studies	13
	203	89/03/00	Electro-Voice RI/FS Data Analysis Work Plan Addendum 1	Fishbeck, Thompson, Carr & Huber, Inc.		Report/Studies	14
	24	89/03/00	Final Community Relations Plan Electro-Voice, Inc.	Jacobs Engineering Group Inc.		Report/Studies	15

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	4	89/03/10	Preliminary Health Assessment for Electro-Voice (Cecil St. Area)	CEHS & MDPH	ATSDR	Report/Studies	16
	234	90/08/00	Final Remedial Investigation Report for Electro-Voice, Inc.	Fishbeck, Thompson, Carr & Huber, Inc.		Report/Studies	17
	488	90/08/00	Final Remedial Investigation Report for Electro-Voice, Inc. Appendices	Fishbeck, Thompson, Carr & Huber, Inc.		Report/Studies	18
	272	90/09/00	Risk Assessment for Electro-Voice Site	Ecology and Environment Inc.	F,T,C&H & Electro-Voice	Report/Studies	19

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Guidance Documents for the Administrative Record
have not been copied, but may be reviewed at the
USEPA Region V-Chicago IL

TITLE	AUTHOR	DATE
Integrated Risk Information System (IRIS) [a computer based health risk information system available through E-mail -- procedure on access is included]	OHEA	00/00/00
Carbon Absorbtion Isotherms for Toxic Organics	Dobbs, R.A./MERL	80/04/01
RCRA Guidance Document: Landfill Design Liner Systems and Final Cover	EPA	82/07/01
Soil Sampling Quality Assurance User's Guide	Barth, D.S. & Mason, B.J. of UNLV	84/05/01
Health Effects Assessment Documents 1,2Dichloroethylene, CIS-1,2-Dichloroethylene Trichlorethylene	ORD/OHEA/ECAO,OSWER/OERR	84/09/01
Practical guide for Ground-water sampling	Barcelona M.J./Illinois St. Water	85/09/01
Chemical, Physical & Biological Properties of compounds present at Hazardous waste sites	Clement Associates, Inc.	85/09/27
CERCLA Compliance with other Environmental Statutes	Porter, J.W./OSWER	85/10/02
Endangerment Assessment Guidance [Secondary Reference]	Porter,J.W./OSWER	85/11/22
Endangerment Assessment Guidance	Porter,J.W./OSWER	85/11/22

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TITLE	AUTHOR	DATE
Mobile Treatment Technologies for Superfund Wastes	Camp, Dresser, and McKee Inc.	86/09/01
Guidelines for Ground-Water Classification under the EPA Ground- Water Protection Strategy	Office of Ground-Water Protection	86/12/01
Interim Guidance on Superfund Selection of Remedy	Porter,J.W./OSWER	86/12/24
Data Quality Objectives for Remedial Response Activities: Development Process	CDM Federal Programs Corp.	87/03/01
Data Quality Objectives for Remedial Response Activities: Example Scenario: RI/FS Activities at a Site w/Contaminated soils and groundwater	CDM Federal Programs Corp.	87/03/01
Data Quality Objectives for Remedial Response Activities: Development Process	CDM Federal Programs Corp/OERR/OWPE	87/03/01
Quality Criteria for Water 1986	Office of Water Regulations & Stds.	87/05/01
Guidelines and Specifications for preparing quality assurance program documentation	ORD/Quality Assurance Management	87/06/01
Guidelines and Specifications for Preparing Quality Assurance	ORD/Quality Assurance Mgmt. Staff	87/06/01

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TITLE	AUTHOR	DATE
Program Documentation		
A Compendium of Techniques Used in the Treatment of Hazardous Wastes	ORD/CERI	87/09/01
Remedial Action Costing Procedures Manual	JRB/CH2M Hill/ORD/MERL/OSWER/OERR	87/10/01
Land Disposal Restrictions	Longest, H.L./OERR Lucero/OWPE	87/11/08
A Compendium of Superfund field operation methods	OERR	87/12/01
A Compendium of Superfund Field Operations Methods	OERR/OWPE	87/12/01
Lining of Waste Containment and other impoundment facilities	Matrecon, Inc./ORD/Risk Reduction	88/01/09
Preliminary Assessment Guidance Fiscal Year 1988	CERR/OERR	88/01/10
Laboratory Data Validation functional guidelines for evaluating organic analyses	EPA Data Review Workgroup	88/02/01
Community Relations in Superfund: A Handbook (Interim Version)	OERR	88/04/01
Superfund Exposure Assessment Manual	OERR	88/04/01
Laboratory Data Validation Functional	EPA Data Rewiew Work Group	88/07/01

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TITLE	AUTHOR	DATE
Guidelines for Evaluating Inorganics analysis		
CERCLA Compliance with Other Laws Manual	OERR	88/08/08
Technology Screening Guide for Treatment of CERCLA Soils and Sludges	OSWER/OERR	88/09/01
Public Health Risk Evaluation Database (PHRED) [User's manual and two diskettes containing the DBaseIII Plus System are included]	OERR/Toxics Integration Branch	88/09/16
Guidance for conducting Remedial Investigations and Feasibility Studies under CERCLA	OSWER/OERR	88/10/01
User's Guide to the Contract Laboratory Program	OERR/CLP Sample Management Office	88/11/01

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REMEDIAL ACTION

ADMINISTRATIVE RECORD

(Index and Documents)

for the

ELECTRO-VOICE SITE

UPDATE NO. 1

BUCHANAN, MICHIGAN

SEPTEMBER 1991

United States Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, IL 60604

INTRODUCTION

These documents comprise the Administrative Record for the Electro-Voice Superfund Site - Update No. 1. An index of the documents in the Administrative Record is located at the front of the first volume.

The Administrative Record is also available for public review at EPA's Region V Office, 230 South Dearborn, Chicago, Illinois, 60604. Questions concerning the Administrative Record should be addressed to the EPA Administrative Record Coordinator.

The Administrative Record is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

Electro-Voice Site
Remedial Action - Update No. 1
Administrative Record

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	7	90/11/15	Letter re: Disapproval of the Draft Feasibility Study Report AOC	E. Reiner-U.S.EPA	R. Graham - Electro-Voice	Correspondence	1
	4	90/12/10	Letter re: Electro-Voice Feasibility Study and Risk Assessment Meeting	K. Wiley-Fishbeck, Thompson, Carr & Huber	E. Reiner-U.S.EPA	Correspondence	2
	4	91/02/28	Letter re: Disapproval of the Final FS Report	E. Reiner-U.S.EPA, RPM M. McAuliffe-U.S.EPA, ORC	R. Graham, Electro-Voice	Correspondence	3
	1	91/03/01	Letter re: Thank you letter for attending the public meeting regarding the results of the RI at the EV Superfund site	E. Reiner-U.S.EPA & D. Jordan-Izaguirre, ATSDR	P. Riley-Area Resident	Correspondence	4
	1	91/03/01	Letter re: thank you letter for attending the public meeting regarding the results of the RI at EV	E. Reiner-U.S.EPA, RPM D. Jordan-Izaguirre, ATSDR	V. Rothfuchs	Correspondence	5
	2	91/03/26	Letter re: Follow-up letter to March 8, 1991 in which we requested a meeting with specific reps. of EPA and MDNR to discuss EPA's letter dated Feb. 28, 1991 regarding the draft FS report	W. Merrill-Varnum, Riddering, Schmidt & Howlett	E. Reiner-U.S.EPA	Correspondence	6
	9	91/03/27	Letter re: Electro-Voice Final FS Report Response to Review Comments	K. Wiley-Fishbeck, Thompson, Carr & Huber	E. Reiner-U.S.EPA	Correspondence	7

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	11	91/04/08	Letter re: Summary of topics discussed in the meeting held Chicago, IL on March 28, 1991	E. Reiner-U.S.EPA	Wiley-FTC&H, D. Calverley	Correspondence	8
	7	91/04/12	Letter re: Follow up to the March 28, 1991 meeting regarding EPA's refusal to allow EV to complete the FS	W. Merrill-Varnum, Riddering, Schmidt & Howlett	M. McAuliffe-U.S.EPA	Correspondence	9
	20	91/04/16	Letter re: Analytical results and laboratory data package for the surface soil samples collected at EV	Fishbeck, Thompson, Carr & Huber, Inc.	E. Reiner-U.S.EPA, RPM	Correspondence	10
	10	91/04/19	Letter re: EV's concern regarding U.S.EPA's alleged failure to comply with the AOC with letters addressing this issue attached	M. McAuliffe-U.S.EPA	W. Merrill-Varnum, etal.	Correspondence	11
	2	91/04/22	Letter re: Clarification of MDNR's position on groundwater remediation at the Electro-Voice site	D. O'Donnell-MDNR	E. Reiner-U.S.EPA	Correspondence	12
	1	91/04/22	Letter re: Clarify that the letter in response to EV's April 12, 1991 was mailed and telefaxed on April 19, 1991 and to confirm that U.S.EPA, MDNR, and EV have scheduled a telephone conference call to discuss the issues	M. McAuliffe-U.S.EPA	W. Merrill-Varnum, etal.	Correspondence	13

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REMEDIAL ACTION ADMINISTRATIVE RECORD

(Index and Documents)

for the

ELECTRO-VOICE SITE UPDATE NO. 2

BUCHANAN, MICHIGAN

JUNE 1992

United States Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, IL 60604

INTRODUCTION

These documents comprise the Administrative Record for the **Electro-Voice Site - Update No.2**. An index of the documents in the Administrative Record is located at the front of the first volume along with an acronym index and an index of guidance documents used by EPA Agency Staff in selecting a response action at the site.

The Administrative Record is also available for public review at United States Environmental Protection Agency, 77 W. Jackson Blvd, Chicago, IL 60604. Questions concerning the Administrative Record should be addressed to the EPA Administrative Record Coordinator.

The Administrative Record is required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA).

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Update No. 2
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	2	91/12/11	Letter re: Request for Information Pursuant to Section 104(e) of CERCLA for the Electro-Voice, Inc. Site	Ronald Graham, Electro-Voice, Inc.	Mary McAuliffe, USEPA	Correspondence	123
	2	91/12/12	Letter re: Comments on the Cleanup Plan for Electro-Voice, Inc. Superfund Site	Donald Ryman, Buchanan Resident	Philip Schutte, USEPA	Correspondence	124
	2	91/12/12	Letter re: Comments on the Electro-Voice, Inc. Superfund Site	Andrew Buchsbaum, PIRGIM	Philip Schutte, USEPA	Correspondence	125
	1	91/12/13	Letter re: Comments on the Electro-Voice, Inc. Superfund Site	Deborah Seager, Mayor, City of Buchanan	Philip Schutte, USEPA	Correspondence	126
	1	91/12/13	Letter re: Additional Public Comments regarding Electro-Voice Superfund Site	Gregory Buckley, Redbud City	Philip Schutte, USEPA	Correspondence	127
	70	91/12/13	Electro-Voice Public Comment Document	Electro-Voice, Inc.	USEPA	Reports/Studies	128
	69	91/12/13	Electro-Voice Public Comment Document	Electro-Voice, Inc.	USEPA & MDNR	Reports/Studies	129
	2	91/12/13	Letter re: Electro-Voice, Inc. Superfund Site	William Merrill, Varnum, Riddering, Schmidt & Howlett	Mary McAuliffe, USEPA	Correspondence	130
	7	91/12/19	Letter re:	Mary McAuliffe,	William Merrill	Correspondence	131

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	4	91/12/20	Memorandum re: Electro-Voice, Inc. Superfund Site	Beth Reiner, USEPA	Various	Memorandum	132
	4	91/12/24	LATE COMMENT Letter re: Response to 12/19/91 letter and follow-up on telephone conference call on 12/20/91	William Merrill, Varnum, Riddering, Schmidt & Howlett	Mary McAuliffe, USEPA	Correspondence	133
	2	92/01/02	Memorandum re: Data Validation for Electro-Voice Groundwater Monitoring Event	Lori Bootz, CH2MHILL	Al Sloan, CH2MHILL	Memorandum	134
	1	92/01/02	LATE COMMENT Letter re: Electro-Voice, Inc. Superfund Site	William Merrill, Varnum, Riddering, Schmidt & Howlett	Mary McAuliffe, USEPA	Correspondence	135
	1	92/01/03	LATE COMMENT Letter re: Electro-Voice, Inc. Superfund Site	William Merrill, Varnum, Riddering, Schmidt & Howlett	Mary McAuliffe, USEPA	Correspondence	136
	1	92/01/03	Phone Conversation Log re: Electro-Voice, Inc. Superfund Site	Beth Reiner, USEPA	Ron Graham	Memorandum	137
	39	92/01/08	Letter re: Electro-Voice, Inc. Response to U.S. EPA 104(e) Request for Information #1-9 responses	Ronald Graham, Electro-Voice, Inc.	Mary McAuliffe, USEPA	Correpondence	138
	6	92/01/09	LATE COMMENT Calculation brief for clean-up tim of a Plume with	Geraghty & Miller, Inc.	USEPA	Reports/Studies	139

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			a Purge Well				
	2	92/01/10	LATE COMMENT Letter re: Submittal of Soil Cover, Ground Water Monitoring, and Ground Water Modelling Documents	Gregory Vanderlaan, Geraghty & Miller, Inc.	Beth Reiner, USEPA	Correspondence	140
	15	92/01/10	LATE COMMENT Electro-Voice Proposed Soil Cover Details	Electro-Voice, Inc.	USEPA	Correspondence	141
	14	92/01/10	LATE COMMENT Electro-Voice Ground-Water Monitoring and Data Analysis Plan	Electro-Voice, Inc.	USEPA	Reports/Studies	142
	392	92/01/15	Certified copies of the Certificate of Incorporation of Gull Company of Buchanan, Inc.	Paul Mitchell, [illegible]opes, Silverstein, Mathias & Wexler	Ron Graham, EV	Reports/Studies	143
	5	92/01/16	Letter re: Electro-Voice, Inc. Superfund Site Summary of Meeting	Beth Reiner, USEPA	Electro-Voice File	Memorandum	144
	6	92/01/24	Memorandum re: Notes regarding conversation with Greg Vanderlaan of Geraghty & Miller, Contractor for Electro-Voice	Mary McAuliffe, USEPA	Electro-Voice File	Memorandum	145
	5	92/01/24	Letter re: Appropriateness of Act 64 as former lagoon area ARAR; waiver of Act 64 as an ARAR	William Merrill, Varnum, Riddering, Schimidt & Howlett	Beth Reiner, USEPA	Correspondence	146
	5	92/01/27	Electro-Voice, Inc., Meeting Notes	Mary McAuliffe, USEPA	Electro-Voice File	Meeting Notes	147

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	1	00/00/00	Letter re: Electro-Voice groundwater contamination	Elaine Curtis	Philip Schutte, USEPA	Correspondence	2
	1	00/00/00	Letter re: Electro-Voice Superfund Site	Robert Faulhaber, Buchanan Resident	USEPA	Correspondence	3
	1	00/00/00	Letter re: Public EPA meeting on 10/30/91 regarding the Electro-Voice Superfund Site	Janet Cooper, Buchanan Resident	Beth Reiner, USEPA	Correspondence	4
	44	81/00/00	Michigan's Solid Waste Management Act	State of Michigan		Reports/Studies	5
	163	89/01/15	Department of Natural Resources Waste Management Division Hazardous Waste Management MI Act 64	MDNR		Reports/Studies	6
	10	89/06/00	Cadillac Area Groundwater Contamination FS	E.C. Jorden CO.	MDNR	Reports/Studies	7
	4	90/06/29	Letter re: Clarification of MDNR's position regarding the application of the Act 307 Rules to remediate the Springfield Township site	Delbert Rector, MDNR	Valdas Adamkus, USEPA	Correspondence	8
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	4	92/02/07	LATE COMMENT Letter re: Clarification of Ground-Water Issues	James Hill, Geraghty & Miller, Inc.	Beth Reiner, USEPA	Correspondence	150
	9	92/02/14	Memorandum re: Comparison of Preferred Remedial Action Alternative Costs Electro-Voice, Inc., Site	Al Sloan, CH2MHILL	Beth Reiner, USEPA	Memorandum	151
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2	06/08/92	Muno, W., U.S. EPA	Adamkus, V., U.S. EPA	Transmittal Letter Requesting Review and Signature of the ROD	1
3	05/24/93	Franks, R., MDNR	Reiner, E., U.S. EPA	MDNR's Review and Approval of the Draft Explanation of Significant Differences	1
4	06/04/93	Adamkus, V., U.S. EPA	Recipients	Explanation of Significant Differences	7
5	06/23/92	Adamkus, V., U.S. EPA	Recipients	Record of Decision (ROD)	95

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2	12/21/94	Golder Associates Inc.	U.S. EPA	Report: "Effectiveness of Subsurface Volatilization and Ventilation System (SVVS) on Groundwater Quality" at the Electro Voice Facility	7
3	01/00/95	U.S. EPA/ORD/RREL	U.S. EPA	Innovative Technology Evaluation Report: "Environmental Improvement Technologies' Subsurface Volatilization and Ventilation System (SVVS)"	106
4	05/02/95	Bradford, W., MDNR	Traub, J., U.S. EPA	Letter re: MDNR's Concurrence with U.S. EPA's Explanation of Significant Difference	1
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6	05/08/95	Chow, E., U.S. EPA	Graham, R., Mark IV Audio	Letter re: Authorization to Proceed with Phase II Remedial Design	1

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3	02/13/96	Graham, R., Mark IV Audio, Inc.	Chow, E., U.S. EPA	Letter Forwarding Attached Correspondence from the Buchanan City Clerk re: City Ordinance 341	3
4	03/25/96	Graham, R., Mark IV Audio, Inc.	Chow, E., U.S. EPA	Letter Forwarding Attached Buchanan City Zone Map	2
5	05/01/96	Harding, R., MDEQ	Adamkus, V., U.S. EPA	Letter re: MDEQ's Concurrence with U.S. EPA's Explanation of Significant Difference	2
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UPDATE #5
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6	03/23/96	U.S. EPA	Public	Explanation of Significant Difference	9

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2	10/00/98	Fishbeck, Thompson, Carr & Huber	Mark IV Industries	Quality Assurance Project Plan for Off-Property Ground-water Evaluation (Second Operable Unit)	366
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2	11/00/92	Fishbeck, Thompson, Carr & Huber, Inc.	U.S. EPA	Groundwater Monitoring Plan for the Electro-Voice Site	69
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8	11/08/95	Chow, E., U.S. EPA	Susan, J.; Fishbeck, Thompson, Carr & Huber, Inc.	Letter re: U.S. EPA's Approval of the Final Remedial Design Documents for the Electro-Voice Site	1
9	10/00/96	Fishbeck, Thompson, Carr & Huber, Inc.	U.S. EPA	Final Phase II Remedial Action Work Plan for Dry Well Area Soils and On-Site Groundwater at the Electro-Voice Site	478

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12	06/00/99	U.S. EPA	Public	Fact Sheet: Proposed Plan for Cleanup of the Electro-Voice Superfund Site	14
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14	07/08/99	U.S. EPA	Public	Public Notice: Announcement of a Public Comment Period and Public Meeting on the Proposed Plan for the Electro-Voice Site	1
15	07/14/99	Bell Reporting Service	U.S. EPA	Transcript of the July 14, 1999 Public Meeting on the Proposed Plan for the Electro-Voice Site	40
16	08/06/99	Wiley, K., Fishbeck, Thompson, Carr & Huber, Inc.	Ostermeier, J. U.S. EPA	Letter re: Mark IV Industries/EVI Audio's Comments on U.S. EPA's June 1999 Proposed Plan for the Electro-Voice Site	3